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THE RELATION OF THE ACADEMY TO THE STATE AND TO THE PEOPLE OF THE STATE[1]

WE are celebrating the twenty-fifth anniversary of an institution whose existence is unknown to the great majority of the people of Ohio. Yet it has enjoyed a prosperous life of a quarter of a century during which it has held many meetings in different parts of the state. At these meetings important results of original research on the part of its members were presented, many of which have been published by the academy and in various scientific journals, thus becoming a part of the great store of learning which the world is accumulating.

The academy can not be fairly charged with undue exaltation of its own merit or importance in the past and, as an incorporated institution of the state it has a right to think that some consideration should now be given to the relations which it might and should sustain to that state and to the people of the state.

As a preface to such consideration it seems desirable to refer to the views of a few persons who would naturally be among its most active supporters did they not believe that under present conditions there is no good reason for the existence of such a society as the Ohio Academy of Science, contending that other organizations of a similar character, mostly national in their scope, offer as good or better facilities for the accomplishment of the principal ends the academy has in view. There is enough ground for such a contention to justify a reply.

Of the many remarkable social evolutions

[1] Address at the celebration of the twenty-fifth anniversary of the Ohio Academy of Science.

that have marked the last quarter of a century none is more curious and interesting than the marvelous increase in the number of societies or groups of people associated together for some special purpose other than what is generally known as "business." It seems to be an accepted theory that if any thing is to be done or ought to be done it is only necessary to form an organization of those who think it ought to be done, after which it is often assumed that in some mysterious way the thing will do itself. There is no part of the country however remote or difficult of access that has not been penetrated by and permeated with this malady, and clubs, associations, circles, etc., have been formed in bewildering numbers and perplexing confusion as to origin and *raison d'être*. Persons cynically inclined have attributed this to the fact that each organization requires a president and other officers and that the universal desire for place-holding is thus gratified. While there is doubtless more truth in this explanation than we would care to acknowledge, the phenomenon is largely the outcome of the modern drift towards specialization in all spheres of human activity. Indeed it is more than a drift; it is a veritable flood-tide and many organizations of recent creation are examples of specialization gone mad.

Scientific men have not escaped this epidemic and during the past twenty years their segregation into groups each of which confines its activities in study and research to a special and often a very narrow field, has gone on with alarming rapidity. Alarming because while there can be no question that science has been and will continue to be greatly advanced by specialization it can not be denied that the man of science has suffered and will continue to suffer from the same cause. Burrowing in a trench, necessary as that operation often is, if persisted in to the exclusion of other occupations, deprives the burrower of that breadth of view and general acquaintance with the topography of the surrounding country which is necessary to the understanding, direction or control of larger operations. It will be admitted that up to the present time the epoch-making generalizations in science have originated with men, who, though profound students of some great subdivision of human knowledge, have not been given to acute specialization. Although we may not expect another Bacon to rise and declare, "I have taken all knowledge to be my province," it is safe to predict that if we are to have in the future discoveries of a magnitude comparable with that of the Copernican theory of the universe, the law of gravitation, the doctrine of evolution or the conservation of energy, they will come from men whose learning is comprehensive rather than intensive. Indeed the same rule must hold in more restricted fields of research. One who devotes himself exclusively to the study of "the abdominal parasites of the white ant" is not likely to evolve from it a new and important biological principle; nor is it probable that an intensive study of conjugate systems of space curves or years devoted to a revision of the atomic weights of the rare metals would carry one far on the way towards an explanation of the nature and cause of gravitational attraction. I would much regret to be understood as deprecating or disparaging specialization in science. It is of the highest importance even in its narrowest phase for through it the phenomena of nature are revealed. But finding how one phenomenon is related to another; the logical grouping of results of observation and experiment and the derivation therefrom of general principles and laws will always call for intellectual powers of a distinctly higher order.

I conclude, therefore, that an organization like the Ohio Academy is of prime importance to science in Ohio because it is essential to the proper and complete development of the man of science. By mingling with those whose explorations of the mysteries of nature are directed along lines diverging greatly from his own he is better prepared to estimate correctly the comparative and the absolute value of his own work. He has also an opportunity to familiarize himself with methods and instruments of research used in other departments of science which he can often summon to his own service with great profit.

In our own National Academy of Sciences there is no division of members into sections in sessions for the presentation and discussion of scientific papers. Communications of the most diverse character are presented before the entire body and this course is highly commended in a recent volume by Dr. George E. Hale, which is a study of the academies of all nations and their relation to the progress of human knowledge.

Unfortunately the history of scientific organizations in this country during the past quarter of a century shows a strong movement in a direction contrary to that which I have suggested as desirable. Forty years ago the American Association for the Advancement of Science was divided into two sections, one of which included those members who were most interested in the so-called "exact sciences," mathematics, astronomy, physics and chemistry, while the other was made up of students of the "natural history sciences." During the week or ten days of its annual meeting there were daily morning sessions in which both sections participated and there were frequent evening meetings at which addresses and lectures were given by eminent scholars representing both grand divisions of science, each chosen for his skill in presenting his subject in such a way that it was intelligible and interesting to members who were on the other side of the dividing line. In this way the mathematician or physicist might always have a fairly correct knowledge of the more important developments or the larger generalizations in biology or geology. The doctrine of evolution, which came first from that side, was quickly appreciated by students of exact science to which it has since been profitably applied. They, in their turn, gave to the naturalists the great principle of the conservation of energy, of which great use has been made in the study of life in its various forms. The psychological effect of the mingling of these two rather diverse elements of the scientific body was also of great value, and there is not the slightest doubt that both were greatly benefited.

In this bi-partite classification of its membership the association had followed the example of its English forerunner in a practise which the latter still maintains. In the American Association the disintegration began about thirty years ago and at present it is divided into twelve sections.

In addition to this specialization within the largest scientific body of the country, during the past twenty years an astonishingly large number of other scientific societies have come into existence, each of which is specially devoted to a particular department or, more often, to a subdivision of a particular department of science. Indeed the pressing need of the hour is the organization of a Society for the Prevention of the Organization of Other Societies.

Perhaps the most deplorable consequence of this minute subdivision in the ranks of scientific men is that, because of habitual isolation from all not familiar with its technical vocabulary little or no effort is made by one group to translate the

results of original research into a language intelligible to any or all of the others. In spite of the sensational vaporizing about scientific men and scientific discoveries that abounds in the Sunday newspapers and fills the pages of popular magazines, it is absolutely true that at the present day there are almost no attempts to popularize science, that is by men who know what they are talking about. A great journal which for half a century was devoted to the exposition of the results of scientific investigation in the vernacular common to educated men has recently been compelled to suspend further publication for lack of support. It seems to be a case in which both producer and consumer have disappeared.

The Ohio Academy of Science is organized in such a way as to afford, it is hoped, an effective check upon this unfortunate tendency. In its sectional meetings opportunity is offered for the discussion of results of research of the most specialized character, while in its general sessions the more important of such results, when finally accepted, may be presented in a manner intelligible and interesting to all. As an illustration of the latter possibility I may be allowed to refer to the great pleasure and profit with which, as one whose intellectual horizon has always been regretfully restricted, I listened at the last meeting of the academy to a most able, interesting and instructive summary of work done in the suppression of the foot and mouth disease.

I think it fortunate that the academy is never likely to be very great in numbers. Let us hope that there will always be at least one institution whose excellence is not to be measured by a numerical standard.

The American Association for the Advancement of Science with its ten thousand members, its twelve sections and its twenty-three affiliated societies, all meeting at one time and place, is an aggregation of parts not very closely related. It no longer affords, as in the early years of its existence, a great opportunity for that commingling in social and scientific intercourse which counted for so much in both pleasure and profit for its members. The smaller, specialized national societies take its place in large measure in this respect, but these fail in one most important particular. In them a man mingles with his kind; it is mingling with the other kind that he often most needs.

Finally, the Ohio Academy, being a state institution, should appeal to all residents of the state who are interested in the advancement of science or the promotion of scientific discovery. The geographic compactness of the state and the network of transportation lines by which it is covered makes it easy for all to attend its meetings, wherever they may be held, while the national societies are usually in session at such distant points that the burden of expense and time makes them impossible for many.

The academy, therefore should be accepted as a very desirable, indeed necessary adjunct to the scientific activities of the state and it is entitled to the loyal support of all residents of the state, especially of those who are actually engaged in scientific work.

Let us now consider its relation to the state under which it enjoys a corporate existence. In answer to the question "What has the state done for the academy?" a single sentence will suffice. A quarter of a century ago the state gave the academy its charter, in payment for which it received the sum of five dollars; about two years ago when the academy desired to correct a slight and hitherto undetected error in its name as recorded in the charter the state graciously allowed one word to be

stricken out, receiving for the stroke another payment of five dollars. That is all. It is not known that the state has in any other way recognized the existence of the academy.

In nearly all enlightened countries there is an organized body of scientific men, existing under a charter which gives it at least a quasi-official standing and the scientific knowledge or technical skill of its members is assumed to be at the service of the government whenever in legislative, administrative or judicial proceedings scientific problems are encountered. In England there is the Royal Society; in France the Academie Française; in Italy the Reale Accademia dei Lincei—the "Royal Academy of the Lynx"—of which Galileo and Colonna were early members, and in the United States we have the National Academy of Sciences, which, though not yet utilized by the national government as completely as would be desirable, has furnished the material on which some of the most important and far-reaching legislation of Congress rests. By the terms of its charter the government may call upon the academy to "investigate, examine, experiment and report upon any subject of science or art." The actual expense of such service is to be paid by the government, but members receive no compensation. In some states of the union in which there are chartered academies of science a similar relation exists and state governments have greatly benefited thereby, but in Ohio the state government has never yet asked its academy to "investigate, examine and report" upon any subject of science or art. This apparent lack of appreciation of the merits of the academy and the possibilities of its usefulness must be attributed to an indifference or ignorance on the part of state officials for which the members themselves may be largely responsible. Believing that it has thus far failed in this, one of its most important functions, I shall dwell a little on what I conceive should be its proper relation to the state in this respect.

I would have the academy act, through its properly constituted committees, as the adviser and counsellor of the state in all matters relating to science or the arts. The necessity for such advice and counsel is becoming more and more evident every year because the sciences and the arts are every year playing a more and more important part in all things affecting the well being of both the state and the people of the state. Eager to secure the benefits of applied science, state and municipal governments as well as private individuals have been guilty of wasteful extravagance in their unreasoning haste to do good to themselves before they know what really is good. During the past few years we have expended many millions of dollars in the building of what we hope will prove to be good roads. Bad grades, lack of drainage, collapsed foundations and crumbling bricks already show that in many instances we shall be grievously disappointed. That the greater part of the enormous loss resulting from such failures might have been avoided is apparent to any one possessing even a slight knowledge of the principles of highway construction.

Several years ago laws were enacted affecting the sanitation of our dwellings and public buildings, fixing in great detail the methods by which connection shall be made with public water supply, sewers, etc. These were supposed to be in the interest of the individual as well as that of the community at large, as a protection against the spread of disease, and the importance of many of them can not be denied. But within a few years it has been proved that many of the restrictions put upon us by our boards of health are quite useless and

unreasonable. We now know that sewer gas is not poisonous and that much of the cost of a system of so-called "sanitary" plumbing may be avoided, as is already done in countries where legislation follows information in such matters. As our sanitary legislation is much of it largely in the interests of a trade union it is rigidly enforced and the unnecessary burden upon the people is by no means light.

Much the same may be said of our laws and regulations relating to the ventilation of school and other buildings. They add greatly to the cost of construction and maintenance but they are far from being in accord with the more recent results of scientific investigation.

The people of Ohio pay, annually, many millions of dollars for a commodity for the measure of which, as it passes from producer to consumer, the state has made no provision whatever. The assumed honesty of the producer is the consumer's only protection.

Many other examples of wastefulness and burdensome legislation and administration might be cited, but these alone, resulting in a single year in a loss many times enough to endow an academy of science in perpetuity, should be convincing evidence that there is great need of wise counsel whenever laws relating to the applications of scientific discovery are under consideration by a legislative body whose members must of necessity be largely ignorant of the basic principles involved.

It will probably be suggested that the state already has at its command a body of scientific and technical advisers in the several faculties of the state universities and that these, being already in its employ, can more appropriately be called upon for service. But there are numerous other institutions of learning, in the faculties of which are to be found men of high scientific attainments and great technical knowledge and skill, men who are recognized by the members of the State University faculties as their peers in every respect, and the state should be glad to be able to avail itself of their accomplishments. Besides these, with whom science or technology is a profession, there will always be other citizens of Ohio (and may their tribe increase) who, though not connected with any educational institution, are lovers of learning and successfully engaged in research in some department of science. Their knowledge and experience may also be made available through the academy, of which they are almost certain to be members. Aside from the fact that the academy will constitute a much larger group than the faculties of the state universities from which expert counsellors may be chosen there can be no doubt that its advice would always have a higher value on account of its independence of action and freedom from political control or legislative influence. Even college professors are not wholly exempt from the weaknesses of human nature and conditions might arise in which it would go hard with them to oppose in report or recommendation a strong movement of the majority of a body of men to whom they must look for appropriations necessary to their continued existence. Instances in which such influence was successfully exerted would be, of course, extremely rare, but suspicion of its presence might be much less so.

There is a weakness in the third of the three great divisions of our governmental system which has long been deplored by all thoughtful people, to the cure of which a state academy of sciences might make a large contribution.

I refer to the use, or rather the abuse of expert testimony in courts of law. Such testimony is generally summoned in trials in which questions arise involving some de-

partment of science or some one of the technical arts. It must be frankly admitted that the scientific expert himself is responsible, more than any one else, for the humiliating fact that courts and juries often have little respect for him and little confidence in the evidence which he furnishes. This unfortunate and unnatural condition is the result of a system which is a disgrace to all who are responsible for it. The scientific expert has allowed himself to become an advocate. All of his tests, experiments and investigations are made to bolster up a particular theory. Phenomena or results of experiments that tend to discredit this theory are excluded from his testimony unless brought out by the skillful questioning of the attorney on the other side, who has been coached by another expert whose tests, experiments and investigations have been made for the purpose of breaking down this particular theory or establishing a different one. Often both of these men know the real truth of the controversy and if locked up in a research laboratory or isolated from outside influence would come to substantial agreement as to every important fact bearing upon it, for two trained observers can never differ long as to the phenomena present in any investigation.

But they have discredited themselves and the great body of scientific men whom they temporarily represent by selling their services as advocates rather than as experts skilled in ascertaining facts.

It has long been recognized that the remedy for this evil lies in the selection of expert witnesses by the court. Attorneys on both sides should be allowed to suggest questions to the court for the experts to answer if the court considers them proper but never to examine or cross-examine the witness directly. The compensation of the witness should be fixed by the court and paid by the state. The court would often find the academy the best source of information regarding the qualifications of experts and would gladly transfer to it the responsibility of making a selection, precisely as some years ago the officers of our national government charged with the administration of the internal revenue laws shifted the responsibility in an important case to the National Academy of Sciences and adopted the recommendations of its committee.

During the past few years there has been much talk (and not much besides talk) about the importance of conserving our national resources, state and national. I need hardly say that the membership of the academy includes men who have studied these resources for many years; who are better informed regarding them than any or all others. Whenever the state shall seriously undertake legislation to secure their conservation it will be a reckless administration that does not apply to them for advice and counsel.

At the risk of being charged with grossly exaggerating the merits of my fellow academicians and others of their kind I venture to refer to one other function of our complex social and industrial life for which I have long thought to be especially well fitted, those men who are thoroughly trained in scientific methods and who have shown their capacity for the original investigation and solution of difficult scientific problems. I mean for service as arbitrators, especially in those cases in which both sides declare there is nothing to arbitrate, each believing, often with perfect sincerity, that his own position is absolutely right and the other absolutely wrong.

Arbitration, in theory the best method of settling disputes, in practise has more often failed than not. It could hardly

be otherwise under the prevailing system. The ordinary procedure is for each side to choose a representative, generally a lawyer, who is pledged to do his best as an advocate, not as a judge. These two after much difficulty, and sometimes by the tossing of a coin, select a third who is often secretly known to favor one side or the other and thus the case is won before it is begun. In the more favorable case of the third arbitrator being open minded and anxious for a correct decision, the points in dispute are confused and obscured by the pleadings of his legal colleagues whose trade is "to make the worse appear the better reason."

In their place put men who have had much training and long experience in discriminating between appearances and realities, whose life work is the ascertainment of facts, the discovery and announcement of truth regardless of consequences, and arbitration would no longer mean a mere temporary expedient or an illogical and unsatisfactory compromise.

Much of the history of modern civilization might be summoned in support of my contention that training and discipline in the methods of scientific investigation may be depended upon above all other processes to give men power to distinguish between the true and the false; to analyze and reconcile confusing and contradictory evidence, and to extract therefrom whatever of truth it may conceal. For such men are guided by the sentiment that inspired Galileo when, in speaking of the Copernican system of the universe and other scientific doctrines which the Pope had condemned he had the courage to say:

> while there can be no doubt that his holiness has absolute power either to admit or condemn, *it is not in the power of any creature to make them to be true or false otherwise than in their own nature and in fact they are.*

Omitting further consideration of the many ways in which the academy might serve the state, and ignoring entirely the intrinsic value of contributions to science which its existence might make possible, I must refer briefly to the reciprocal obligation of the state to the academy.

In the beginning the question was asked, "What has the state done for the academy?" and the answer was, "nothing." My answer to the question what *should* the state do for the academy is almost as brief. It is, "not much." Its usefulness to the state will depend largely on its being free from state control or departmental influence. At the same time their mutual relations should be close enough to justify the state in calling upon it at any time for services of the kind I have indicated. The provision in the charter of our National Academy already quoted seems to be quite satisfactory. In return for services which in time will become both numerous and valuable the state should do two things for the academy. It should undertake the publication of its annual reports, including monographs, memoirs and other contributions to its proceedings which are judged to be of sufficient interest and importance to the people of the state. This is already the practise of several states in which academies of science flourish and it is done by the national government for the National Academy. It should also provide a suitable building in which the regular meetings of the academy could be held, where its archives and collections could be stored and where its special committees could hold their meetings and prepare their reports. This is certainly a modest demand if the members of the academy pledge themselves in return to give to the state without cost, in the form of advice and counsel, the full benefit of their scientific training and technical skill.

During the past few years in public and private speech, in books, newspapers and magazines the word "efficiency" has been heard and seen almost *ad nauseam.* The better the horse the more we are inclined to ride it to death, but that phase of the meaning of this word which implies making full and economic use of all our varied resources must in the end enjoy a useful survival. From the awful calamity which has fallen upon the world in the form of a general European war there are many lessons to be learned, not the least important of which is to discover the origin and cause of the marvellous efficiency of the military forces of one of the great nations involved, or rather, of the people of that nation, or still more accurately, of the nation as a whole, which has displayed a capacity for the immediate and complete utilization of every available resource, animate and inanimate, that has commanded the admiration of even its most bitter foes.

For one of the principal sources of this efficiency we have not far to look.

In 1893, when every nation of the world was collecting the best examples of its material resources and industrial products for exhibition at the great World's Fair held at Chicago in celebration of the four hundredth anniversary of the discovery of America, an old man in Berlin was commanded to present himself at the Royal Palace for an interview with the Emperor of Germany. To him spoke the Kaiser, saying:

> We are sending to America the finest products of our factories, our mills, our fields and our mines; some of our choicest works of art will be there, but above all of these Germany is most proud of the men she produces. You are the best we have and you must go to represent us.[1]

[1] This is no imaginary interview. I have given as nearly as possible the exact words used by Baroness von Helmholtz in telling me of it afterwards.

The man thus addressed was not a field marshal of the German army, or an admiral of her navy, her most famous diplomat or her richest iron-master. He was Herman Ludwig Ferdinand von Helmholtz, Germany's greatest natural philosopher, at once the most versatile and profound scholar of the nineteenth century.

The incident is well worthy of our attention as a striking illustration of the value which is set upon men of science and their work by the German Empire. During the past fifty years no other nation has so encouraged scientific research and by no other nation have scientific discoveries been so readily accepted and so quickly utilized. In all legislation upon economic questions the man of science has had paramount influence, and in that greatest of all economies, the prevention of unnecessary waste and the getting out of every material thing the last drop of usefulness, the Germans, from prince to peasant, have no rival.[2] The administration of her municipal governments is a model for the rest of the world, because the advice of the scholar has been sought at every turn. All of her foremost industrial enterprises have had their beginning in the laboratory. In many important lines she has controlled the markets of the world, not on account of her su-

[2] A personal experience, amusing but instructive, may be worth relating. While living in one of the largest cities in Germany I ordered a suit of clothes from a good shop on one of the principal streets. On the first trial of the coat I failed to find the small "change" or ticket pocket usually on the right side. When I called attention to its absence the tailor showed me that it had been put in on the *inside* of the larger pocket below, explaining that if he put it where it is usually placed by American or English workmen it would be *impossible to have the coat turned,* as the cut in the cloth would then show on the left side! And when I expressed my preference for the usual location he remarked, "Nearly every gentleman in Germany has his coat turned once."

perior business or commercial intelligence but because of the knowledge and technical skill of her chemists.

Whatever we may think of the outcome it can not be denied that it is *applied science* that has enabled the German Empire to suddenly convert itself into a huge engine of destruction, all parts of which seem to have been so delicately adjusted to each other that the awful strain to which the whole is now subjected is distributed among the several members in exact proportion to their ability to bear. Other nations are learning this lesson in the hard school of experience and they are paying tuition in blood and treasure.

Fortunately for us it may be learned by observation as well as by experiment.

T. C. Mendenhall

November 9, 1915

HISTORICAL SKETCH OF THE OHIO ACADEMY OF SCIENCE

Twenty-five years ago the first decisive steps were taken looking toward the organization of an Ohio Academy of Science. At the annual meeting of the Biological Club of the State University held November 3, 1891, the retiring president made a short address in which he said substantially: There is need of one institution in Ohio to the organization of which our club should direct its combined energy and influence. This is a state academy of science. If local clubs and societies of science are beneficial, the reasons that make them so apply with greater force to a state organization. Who can estimate the inspiration, the stimulus to research and investigation, that such an institution would provoke? In a great agricultural state like Ohio, a deep, abiding and constantly growing interest will ever be taken in the sciences of geology, botany and chemistry, for these constitute the very foundation, the body and bones, of any rational basis of practical knowledge regarding soils and the various crops that grow thereon. But our State Academy would not be confined to the sciences that relate so directly to soils and crops. All branches of biology, as well as physics, chemistry, mathematics, anthropology, meteorology, economics, sociology, etc., everything that contributes to the sum total of scientific knowledge, should find a place. The initial steps toward the founding of such an academy should be taken by this club, and to-night. This can be done by the appointment of a committee, which should energetically push the matter by preparing a program for a meeting, and issuing a call to all interested, to assist in the organization. In pursuance with this declaration the club appointed a committee consisting of D. S. Kellicott, W. A. Kellerman and the speaker to take such measures as in their judgment were deemed best to carry into effect the wishes of the Biological Club.

The committee soon secured the promise of hearty cooperation from many of the most prominent scientists in Ohio, and issued a call for a meeting to be held in Columbus, December 31, 1891.

The meeting took place at the date named, and appointed a committee on organization consisting of W. A. Kellerman, of the Ohio State University; E. W. Claypole, of Buchtel College; and Henry Snyder, of Miami University.

While the committee just named were preparing a constitution and by-laws, papers were read by Dr. A. M. Bleilie, E. E. Bogue, J. M. Bradford, H. E. Chapin, H. J. Detmers, W. A. Kellerman, D. S. Kellicott, H. A. Weber, W. C. Warner and A. A. Wright.

After the adoption of a brief but comprehensive constitution and a few simple by-laws, the organization was completed by the election of the following officers to serve the

first year: President, E. W. Claypole, Buchtel College, Akron; Vice-presidents, A. A. Wright, Oberlin, and Ellen E. Smith, Lake Erie Seminary, Painesville; Secretary, William R. Lazenby, Ohio State University, Columbus; and A. D. Selby, Treasurer, Columbus, Ohio. Elected as members of the Executive Committee were E. T. Nelson, Ohio Wesleyan, Delaware, and A. D. Cole, then of Denison University, Granville. It should be noted that of the seven elected officers only two, the secretary and treasurer, were residents of Columbus, and connected with the state university. I mention this to show that from the very outset, the academy has been a state-wide institution and in no way restricted or limited to any one section of the state. Attention is also called to the fact that the charter members of the academy, fifty-nine in number, included mathematicians, chemists, physicists in generous proportions.

It was also quite representative of the educational institutions of the state that were interested in science. Besides the state university which naturally had the largest number, the following universities and colleges were represented: Buchtel, Cincinnati, Denison, Miami, Mount Union, Oberlin, Ohio, Ohio Wesleyan, Otterbein, Starling Medical, Western Reserve and Wilmington. Lake Erie Seminary and the State Experiment Station, as well as the high schools of Alliance, Cincinnati, Cleveland, Columbus, Chillicothe, Dayton, Defiance, Geneva, Kent, Portsmouth, Sandusky, and Tiffin were likewise represented.

At the first meeting the secretary was instructed to secure articles of incorporation, and to publish the constitution and by-laws, together with a list of the officers and members.

In accordance with the above instructions, a certificate of incorporation was duly filed with the Secretary of State on March 12, 1892. This certificate bore the following names as incorporators of the Ohio State Academy of Science: W. A. Kellerman, F. M. Webster, A. D. Selby, W. C. Werner, E. E. Bogue and W. R. Lazenby. Of these incorporators Professors Kellerman and Bogue have passed away.

The academy held its first field meeting in Summit County on June 3 and 4, 1892, the headquarters being at what was then Buchtel College, in the city of Akron.

The program for the field-day included an excursion by steamer to Long Lake, and the day was spent in and about the attractive "Lake District" of Summit County. The botanists observed the rich and varied plant societies of the swamps, and the geologists were interested in the great moraines to which, in part at least, the swamps, ponds and lakes owe their origin. In the evening a reception was held in the gymnasium of Buchtel College, at which the visitors were welcomed by the mayor of Akron, the president of the college, Dr. O. Cone, and the president of the Akron Scientific Club.

The next day at an early hour the members and visitors set out for Cuyahoga Falls, where they were cordially welcomed. They were conducted some three miles through the post-glacial gorge of the Cuyahoga River.

This excursion was equally interesting and profitable. The geologists and botanists and entomologists improved the opportunity and added to their stores of scientific facts.

After the passing of a quarter of a century, I can look back upon this as one of the red-letter days of my life.

What was called on the program the first annual meeting, although in reality the second, was held in Columbus, December 29 and 30, 1892. At this meeting twenty-five papers were read. The papers were for the most part on some phase of botany, geology

and entomology. Perhaps the most significant action at this meeting was a brief report of the Committee on Publications, which announced that it had selected the *Journal* of the Cincinnati Society of Natural History and the technical series of *Bulletins* of the Ohio Experiment Station, as the official organs of the academy, until better arrangements can be made.

At the close of this second annual meeting, although in reality the end of the first year of the existence of the academy, the total membership was as follows: Annual members 116—of which number 59 were charter members, and one life member, Mr. Emerson McMillin, who at this early day became a generous patron.

Having dwelt in some detail upon the founding and early history of the academy, I shall treat its subsequent career and accomplishments more briefly.

Statistics are usually wearisome, but in the interests of history they can not be wholly avoided.

What may be termed the annual membership of the academy has increased from 59 charter members in 1891 to 234 members in 1915. About one fifth of the membership reside outside of Ohio, and are found in 15 different states, besides the District of Columbia, Hawaii and Canada. The Ohio residents are found in more than 50 counties of the state.

To illustrate the regularity of growth in numbers, the fifth year the membership was 157; tenth, 173; fifteenth, 179; twentieth, 196; twenty-fifth, 234.

As to attendance, one can not speak confidently, for no records have been kept. On the average I should say that one third of the resident membership have attended the annual meetings. As to place, fourteen of the twenty-five annual meetings have been held in Columbus, two in Granville, two in Cincinnati, two in Cleveland, one each in Oxford, Delaware, Akron and Oberlin.

Summer meetings have been held in well-selected places in the following counties: Summit, Hocking, Licking, Erie, Butler, Knox, Montgomery, Franklin, Ottawa and Wayne. Several of these were joint meetings with other organizations. For instance, in Butler County with the Indiana Academy of Science; in Franklin County with the American Association for the Advancement of Science (the summer meeting of 1899); at Put-in-Bay with the Ohio Teachers Association, and in Sandusky County with the same organization. These delightful meetings were held each year for the first ten years in the life of the academy. For some reason, unknown to me, they then ceased. Would it not be well to renew them? As summer schools are now held at many points in Ohio, it might be advisable to arrange a meeting of a day or two with the scientific departments of some one of these schools.

The papers presented during the twenty-five years number 1,124, or an average of 45 for each meeting. The range in number is from 10, read at the first meeting, to 64, read at the fifteenth. At the twenty-fourth meeting the number was 61, and at the twenty-fifth it was 58.

Cloud and sunshine, joy and grief, are common contrasts in our life. We experienced these contrasts at the eighth annual meeting. The first serious break in the ranks of our membership had then occurred. Two of our ablest members were missing. We grieved that Dr. Kellicott had been stricken by death, and that Dr. Claypole had left Ohio to spend the remainder of his days in the more genial climate of California.

At the same time we rejoiced that one who had already proven himself a friend should modestly announce that he had given the academy $250, to be expended in ways best suited to promote scientific research; with the further statement that such a sum

might be given annually, provided the use made of the money was satisfactory and it proved convenient for the donor to spare it. We may assume that these conditions have been fulfilled, for from that day to this, or for eighteen successive years, this generous gift has been received. It has come to us quietly, promptly and without solicitation during all this time.

It has been administered in the same quiet way, and not one penny has been used for anything except to aid in research, or the publication of its results.

The influence of this gift has been as gentle and persuasive as the spring sunshine or summer shower. Nearly a score of special papers have been prepared and published by the academy through its aid. As many more have been published elsewhere. All honor to this scholarly, efficient, large-hearted, high-spirited man. I trust he believes that "the reward of a good deed is to have done it," if not, I don't know how he is to be paid.

We are here to-day in a spirit of congratulation. We congratulate our academy upon what it has accomplished. We congratulate Emerson McMillin on what he has done for the academy.

We congratulate the universities, colleges and high schools of Ohio that so large a number of their instructional force are active workers in our academy. Our annual meetings have confirmed and strengthened a spirit of good will between the educational institutions of the state. They have cultivated the amenities, and developed a feeling of brotherhood among our members. Our academy since its inception has stood for good scholarship, good fellowship and good citizenship. The essentials of a great landscape are unity and variety. These are likewise the great attributes of an association for the promotion of science. Unity in the spirit and ideals of the work to be accomplished, and variety, infinite variety, in the means by which these ideals may be developed. We come together on the basis of commanding interests and diverse experiences. This devotion to the varied phases of science detracts nothing from the pursuit of the older humanities, but adds materially to the effectiveness of any study that puts the student in closer touch with his environment—in closer touch with nature—and nature's law. This spirit was in Orton and Kellicott and Claypole, who were among the founders of the academy. What a fine influence these men exerted! What fine lives they led! It was a happy blending of the strenuous, the simple and the abundant life.

Strenuous, because in addition to the enforced and exacting labors of a teacher were added the self-imposed tasks of the investigator; simple, because they lived close to nature and her laws were the rule and guide of their daily conduct. They had neither time nor means for luxury. And most of all their lives were abundant; abundant in opportunity, abundant in accomplishment, abundant in honors, abundant in friendship. Demanding little, they received much. They are of those who, losing their lives, save them.

We are together to celebrate an epoch, not alone in the promotion of science, but in the attainment of the ideals of education; ideals for which the academy will stand in the future as in the past.

WILLIAM R. LAZENBY
OHIO STATE UNIVERSITY

THE NAVAL CONSULTING BOARD OF THE UNITED STATES[1]

THE so-called "five-million laboratory," proposed by the Naval Consulting Board,

[1] From an address made before the joint meeting of the New York Section of the American Chemical, the American Electrochemical Society, and the Society of Chemical Industry, by Dr. L. H.

has been the favorite subject of varied and picturesque criticisms which, as usual, originated more through lack of information than by ill-will.

Secretary Daniels requested each member to address to him his personal opinion on the advisability of the creation of a research laboratory where urgent technical matters relating to the needs of our navy could be studied successfully.

At the second meeting a special committee was appointed to submit a joint report. On this committee were, besides Mr. Edison, four other members. One of the other members of the committee is a man who has earned a national reputation in organizing and developing one of our largest mechanical industries. The second member is at the head of perhaps the largest and best endowed scientific research institution of the world; another is the chief of one of the most successful chemical and physical industrial research laboratories of this country; the fifth has devoted much of his life to private chemical research.

It was interesting to follow how the five members grouped themselves in accordance with their own point of view, dictated by their daily scope of action: The chemical or purely scientific members of this committee agreed pretty well on the kind of research laboratory they had in view, and although their suggestions had been written independently without consulting each other, their general recommendations as to the organization, equipment, and needed expenditures were fairly similar and relatively modest.

But their recommendations were mainly limited to a chemical and physical laboratory; they did not include the study of elaborate mechanical and technical problems which go far beyond the questions which are usually dealt with in chemical and physical research laboratories.

The two other members, on the contrary, wanted to prepare thoroughly for engineering problems of immediate importance, the solution of which seems indispensable if the money of the navy is to be spent to best advantage.

They set forth, from their own direct experience, how very expensive such engineering experimental work is likely to be.

Edison, for instance, pointed out the millions he spent in developing some of the details of his inventions; another member identified with the automobile industry stated that one single automobile concern here in the United States had found it necessary to spend half a million dollars in one year for experiments and research.

The modest estimate for a merely chemical and physical laboratory was thus snowed under by the irrefutable evidence of the much larger needs for a suitable mechanical or engineering department.

Of course, it was argued that the Navy possesses already several experimental stations at its different navy yards, and at the torpedo station in Newport, aside from the different testing laboratories for the materials used for ordnance or ammunition; that, furthermore, the excellent laboratory facilities of the Bureau of Standards are available.

The answer to this was that each and every one of the present institutions were more necessary than ever, but were totally insufficient; furthermore, the full cooperation of all of them is needed; all this in view of the fact that, at present, the navy of this country is facing unusual responsibilities.

If it is deemed urgent to be prepared for defense then this defense involves problems the solution of which can not be deferred

Baekeland, member of the board, and printed in *Metallurgical and Chemical Engineering.*

indefinitely. If something has to be done, it must be done immediately—not in five or ten years hence, when it may be too late.

In all of our present scientific research laboratories, time seems of relatively little or no account; problems which can not be solved to-day can be solved to-morrow or in ten years or during the next generations; but this is not the case with the problems connected with the contemplated defense of our country; the solution of these problems can not be postponed. They demand immediate action.

Nor is the condition of our navy similar to that of an industrial concern that can afford to take chances with machinery or equipment which is not strictly up to date, and still show some commercial success. For instance, recent events have demonstrated that there is no use building the best and newest fortresses against an enemy who possesses guns strong enough to demolish everything in existence.

Nor is there any chance of success in using the very best artillery at anything like equal chances if your adversary can do his scouting and range-finding with aeroplanes provided with reliable engines, while your aeroplanes are equipped with motors which give out at unexpected moments.

In our clumsy war with weak Spain, we went into the field with black powder when all other nations, even Spain, were equipped with smokeless powder. Why? Because we had postponed too long studying the chemistry of the subject.

The fact is that if we require a navy at all, our navy can not afford to use anything but the very best and most efficient means of defense. Not to possess the very best might put us in the same absurd condition as the wooden navies of the world were in after our civil war had established the supremacy of the iron-clad vessel.

The contemplated outlay for the navy for the next five years, for new ships, aviation and reserve of munitions, amounts to about $500,000,000. These tremendous expenditures of money, in order to be of real value, ought to be made as efficient as possible. All doubtful and inferior devices must be eliminated by direct experiment, by research and tests, *before* it is too late to remedy them.

This requires accelerated action; in fact, Mr. Edison's personal opinion was that research and laboratory work in this instance "should go on night and day without intermission" instead of the usual easy-going short-day plan followed in laboratories.

If one single automobile concern in the United States finds it to its advantage to spend in one year half a million dollars on testing, research, or experimentation, how much more important is the business of the United States navy, where money not spent wisely is better not spent at all, because then at least we shall not have the illusion that we are equipped for defense, when we have merely lost our money on antiquated devices.

Without mentioning any spectacular problems of modern warfare, it might be stated that such a prosaic detail as the corrosion of condenser tubes of our war ships involves an annual damage of about $2,000,000. If $1,000,000 were spent on research on this problem alone, with the result of reducing the damage to one half the total outlay would be compensated in a few months' time, aside from the important fact that our fleet would be stronger because less of our ships would be unavailable for service.

It was brought out that there was little use in spending so many millions on flying machines as long as there was any doubt on the reliability of their engines, and until an absolutely well-tried and standardized

engine had been developed. To accomplish this experimental work in a period of a few years would cost some money; but to do this rapidly, within a few months, before order is given to build these flying machines, requires enormous outlays of money, alongside of the indispensable engineering talent.

Another member brought out the fact that even conservative industrial enterprises found it necessary and profitable to spend at least 2 to 5 per cent. of their sales on research and experiments. At this rate, the contemplated expenditure of $500,000,000 in five years would certainly warrant an expenditure of at least five million for research during that period.

Money for this purpose, wisely used, ought to do so much good to the navy as to increase its efficiency by the value of several battleships costing considerably more. Mr. Edison's arguments were particularly eloquent when he enumerated the enormous expenditures for research in his own laboratories.

In this discussion everybody seemed to be well in accord with the general idea that whatever expenditures were recommended, the contemplated work should be carried out under immediate supervision of the navy; that this work should not be started all at once—full blast—but should be extended gradually, as fast as circumstances demand it.

In view of all this, two policies were open for obtaining the necessary appropriations —the old time-honored trick of asking from congress first an appropriation of a few thousand dollars, knowing very well that this would be insufficient, then after awhile ask an additional appropriation and keep on nagging and asking at various intervals.

But the members of the advisory board thought it a more honest policy to state the facts as they saw them and to confront the secretary of the navy with the probable maximum expenses for research and experimentation, commensurate to the five years' naval building program now under contemplation. The five-million dollar budget for experimental work to be expended during those five years, or about one million a year, may strike the uninitiated as needlessly large, although it is only about what some industrial enterprises have found necessary to spend on their own experimental work.

But if the nation does not want to go to the expense of developing the latest and most efficient means for defense at the lowest cost by obtaining the necessary information through preliminary experiments, instead of committing mistakes on a large permanent scale; or if our country wants its navy to keep on building its ships or other means of defense, as were good enough in the past, regardless of the fact that modern war requires the very latest and the most efficient available devices, then let us not be astonished if after incomparably more money has been spent for increased armaments, we find that we are loaded with means of defense which have become obsolete in the meantime and are merely good for the junkheap of antiquated equipment.

The foregoing is a brief résumé of various arguments which were submitted by some members of the board, and this is the first time that this discussion has been reported in public. Let us hope that its publication may help to dispel some of the ideas of the public which imagines that the board contemplates the immediate erection of a "$5,000,000 laboratory building, where the members of the Naval Consulting Board can experiment to their hearts' content in company with long-haired inventors."

As Mr. Edison expressed it picturesquely:

"The money should be spent not on buildings, but on a national junkshop," where means of defense can be tried out first, at relatively small cost so as to learn how to get the most and very best for the money, and so as to avoid making expensive and dangerous blunders on a wholesale scale.

SCIENTIFIC NOTES AND NEWS

THE American Association for the Advancement of Science and the scientific societies affiliated with it meet at the Ohio State University, Columbus, Ohio, beginning on Monday, December 27. The program of the meeting has been printed in SCIENCE, and details in regard to the places of meeting and the officers of the different societies that meet during convocation week will be found elsewhere in the present issue of the journal.

WE have not been able to obtain any program of the Pan-American Scientific Congress which meets in Washington for two weeks beginning on December 27. It is possible that after the adjournment of the Columbus meeting of the American Association, the council will call a special meeting at Washington in conjunction with the congress.

THE nineteenth International Congress of Americanists and the affiliated societies, meeting in Washington from December 27 to 31, has an extensive program on which are represented most American anthropologists and a number of foreigners.

THE State Geographical Society of New Mexico was organized in October with David Ross Boyd, Ph.D., president of the state university as president, and Governor McDonald, Senator Catron, Ex-Governor Prince and Professor C. T. Kirk, as vice-presidents.

DR. ERASMUS KITTLER, known for his work in electro-technics, has been awarded an honorary doctorate of engineering by the Darmstadt Technical School.

DR. ALBERT STUTZER, professor of agricultural chemistry at Königsberg, will retire from active service at the close of the present semester.

DR. HUGO FISCHER has been appointed acting head of the chemical and bacteriological department of the Kaiser Wilhelm Department for Agriculture in Bromberg.

KING FERDINAND, of Bulgaria, has been removed from the membership in the Entomological Society of France, which he has held since 1882. His name has also been erased from the membership list of the Petrograd Entomological Society. In this society there has been elected in his place, M. Lameere, of Brussels, who is now working in the Paris Museum of Natural History.

THE Massachusetts Agricultural College at Amherst has sent Professor F. A. Waugh to lecture to the students in landscape gardening at the University of Illinois. In exchange, the Illinois Agricultural College has sent Professor R. R. Root to take charge of the classes of Professor Waugh at Amherst.

DR. CHARLES S. PALMER, formerly professor of chemistry in the University of Colorado, and later consulting chemical engineer for various manfacturing interests in New England, has recently accepted a fellowship in the Mellon Institute for Industrial Research of the University of Pittsburgh.

AT the last meeting of the Rumford Committee of the American Academy of Arts and Sciences, the following appropriations were made: $200 for the purchase of a comparator to be used by Mr. Raymond T. Birge, of Syracuse University, in his researches in spectroscopy. $400, in addition to a former appropriation, to Professor P. W. Bridgman, of Harvard University, in aid of his researches upon thermal phenomena under high pressures. $300, in addition to a former appropriation, to Professor A. L. Clark, of Queens University, in aid of his researches on the physical properties of vapors in the neighborhood of the critical point. $300, in addition to a previous appropriation, to Professor Gilbert N. Lewis, of the University of California, in aid of his researches on free energy.

PROFESSOR BENJAMIN MILLER, of Lehigh University, and Dr. Joseph T. Singewald, Jr., associate in economic geology at the Johns

Hopkins University, have returned from a seven months' tour of South and Central America, bringing with them a valuable collection of ores.

Dr. Walter Penck, docent for geology at Leipzig, has accepted a chair of geology at Constantinople.

Dr. Frederick Parker Gay, professor of pathology in the University of California, has been chosen by his colleagues in the faculty of the University of California as faculty research lecturer for 1916, and will give this annual public address on the results of his own research in some special field at the University of California on the evening of Charter Day, March 23, 1916. His selection was in recognition of his recent work in developing improved methods for the treatment of pneumonia, a new method for the treatment of typhoid fever by the use of a sensitized vaccine, his researches, in collaboration with Dr. Edith J. Claypole, in the field of immunization against typhoid, and his development in association with Dr. J. N. Force of a skin test as to immunity against typhoid.

A series of free public lectures for amateur gardeners and those interested in plant growth has been established at the University of Pennsylvania. The lectures are being given on Wednesday evenings by Dr. John M. Macfarlane, professor of botany and director of the botanical gardens of the university.

Professor Robert A. Millikan, of the University of Chicago, addressed the Washington University chapter of Sigma Xi in St. Louis on November 30 on the subject "Atomism in Modern Physics."

A bust of Alphonse Bertillon has been unveiled in the Paris Bureau of Anthropometry.

Dr. A. Alexander Smith for many years professor of medicine in the Bellevue Hospital Medical College, and in the combined University and Bellevue Hospital Medical College, died on December 13, in his sixty-ninth year.

Dr, Alexander T. Ormond, president of Grove City College, formerly professor of philosophy at Princeton University and a distinguished writer on philosophical subjects, died on December 18, aged sixty-seven years.

Lieut.-Col. Charles S. Bromwell, head of the Army Engineer Corps at Honolulu, died by suicide on December 10 at the age of forty-six years. He had served as superintendent of public buildings in Washington and as military aid to President Roosevelt. During the past year he had been in Honolulu, where he was in charge of the engineering work in connection with the improvement of the harbor and the construction of the new breakwater at Hilo.

Dr. Peter Vogel, professor of mathematics in the artillery and engineering school at Munich, has died at the age of fifty-eight years.

Dr. Friedrich Quoos, assistant in the chemical laboratory of the Charlottenberg Technical Institute, has been killed in the war.

Surrogate Cohalan has upheld objections by Mrs. Lida Pope Colburn to the will of her husband, Richard T. Colburn, on the ground that the laws of the state of New York do not permit a testator whose wife is living to bequeath more than one half of his estate to educational or scientific institutions. He died on December 9, 1914, and left the bulk of his estate of $297,537 to the Carnegie Research Fund [Carnegie Institution of Washington] and the American Association for the Advancement of Science for original research in "physical or psychic demonstrable sciences." Mr. Colburn gave an annuity of $1,200 to his widow, and said he gave her no more "in order not to tempt her into unsound investments, speculations or lures of fortune hunters, charlatans or parasites. A modest scale of expenditure is my injunction to her." The two institutions will divide half the estate and each will receive about $75,000.

At the annual meeting of the New York Academy of Sciences, on December 20, at the Hotel Manhattan, through the courtesy of the telephone company, there was arranged a somewhat extensive program of communication with the Pacific coast. This included photographs of the line and of its construction, conversation between officers of the California Academy

of Sciences and officers of the New York Academy of Sciences, music at San Francisco, and other demonstrations,—all audible to all participants by individual receivers.

The Plant World announces the offering of two prizes for the best papers embodying original work in soil physics. The first prize will be $50 and the second $25, with the reservation of the right to withhold both prizes if no worthy papers are submitted or to combine the prizes for the rewarding of a paper of exceptional merit. The conditions governing the award will be similar to those employed in connection with the prizes for papers on the water relations of plants which were offered in April, 1915. The contesting contributions should be in the hands of the editor of *The Plant World* by December 1, 1916, and the announcement of the award will be made not later than March 1, 1917.

THE annual series of free public lectures under the auspices of the Harvard Medical School will be given, as usual, at four o'clock on Sunday afternoons at the Harvard Medical School. The lectures are:

January 2.—Dr. R. B. Greenough: "Cancer."

January 9.—Dr. W. H. Potter: "Military Dentistry; Experiences in a Three Months' Service in the American Ambulance Hospital, Paris."

January 16.—Dr. R. P. Strong: "Progress in Combating Epidemics of Some Infectious Diseases."

January 23.—Dr. R. B. Osgood: "Orthopædic Problems Presented by the European War."

January 30.—Dr. J. A. Honeij: "Leprosy."

February 6.—Dr. C. M. Smith: "Syphilis."

February 13.—Dr. F. H. Verhoff: "Some Simple Facts Regarding the Eyes that every one Should Know."

February 20.—W. H. Robey, Jr.: "The Value of Physical Examination to the Individual."

February 27.—Dr. C. J. White: "Occupation as a Contributing Factor to Certain Skin Diseases."

March 5.—Dr. W. R. Bloor: "The Rôle of Fat in the Nutrition of Man."

March 12.—Dr. F. S. Newell: "The Care of Pregnancy." (To women only.)

March 19.—J. L. Goodale: "Hay Fever and Asthma."

March 26.—Dr. F. W. White: "Chronic Indigestion."

April 2.—Dr. J. R. Torbet: "A Comparison of the Methods for the Relief of Pain in Childbirth." (To women only.)

April 9.—Dr. P. G. Stiles: "The Present Conception of an Adequate Diet."

April 16.—Dr. G. B. Magrath: "Death by Accident; Some of its Causes and How to Eliminate Them."

April 23.—Dr. H. P. Mosher: "The Management of Foreign Bodies in the Trachea, Bronchi and Esophagus."

April 30.—Dr. C. V. Chapin: "What the Individual Can Do to Protect Himself from Infection."

May 7.—Dr. R. I. Lee: "The Importance of Physical Examination in Health as Shown by the Examination of Harvard Students."

THE exploring excavations in the Mesa Verde National Park which the Department of the Interior is conducting under the direction of Dr. Jesse W. Fewkes, of the Smithsonian Institution, are successful to a degree scarcely anticipated when the work was begun, according to a statement by Mr. Enos Mills, sent out by the Department of the Interior. The new excavations are across the canyon from the Cliff Palace. This remarkable prehistoric village stands beneath the rim of the east side of the canyon while the structure now unearthed stands upon the rim of the west side. For many years visitors to the Mesa Verde National Park have noticed a huge mound opposite the Cliff Palace with trees growing upon it. It is this mound which the Department of the Interior determined to explore and under which Dr. Fewkes has found the most remarkable prehistoric structure north of the Aztec architecture in Mexico. It is of cut and polished stone. The building has the form of a capital D. The straight elevation is 123 feet long and the curved part 245 feet. The outer walls are double and between them are a series of narrow rooms. As the outer walls are unbroken, the entrance to this building must have been either subterranean or by the means of ladders through the top. Dr. Fewkes believes the ruin was an uncompleted fortress abandoned when the cliff dwellers disappeared from the Rocky Mountain region. At Moki Spring, a short distance from these ruins, there are a number

of other tree-grown mounds very similar in appearance to the one just excavated. Dr. Fewkes hopes next year to find what is concealed beneath.

UNIVERSITY AND EDUCATIONAL NEWS

The contest over the will of the late General Brayton Ives, who left the bulk of his estate, valued at more than $1,000,000, to Yale University, has been settled by the filing of an order in surrogate's court. The contest was begun by General Ives's three daughters. The terms of the settlement were not divulged.

The Duhring Memorial Building was formally dedicated on December 13 by the trustees of the University of Pennsylvania, and a memorial tablet was unveiled at the entrance to the new book stack. This new building is a wing to the library, and was erected as a memorial to the late Louis A. Duhring, professor of dermatology at the University of Pennsylvania, who left a legacy amounting to more than a million dollars to the university. The dedicatory addresses were made by Professor Morris Jastrow, Jr., the university librarian, and Dr. Joseph G. Rosengarten, chairman of the library committee of the board of trustees. The building was accepted on behalf of the university by Provost Edgar F. Smith.

A new building known as the Vivarium will soon be completed at the University of Illinois. It has been constructed especially for the work of Dr. Charles Zeleny and Dr. V. E. Shelford, of the department of zoology. The building, with furnishings, will cost about $70,000. Seawater aquariums, a refrigerator system, and rooms in which light rays may be used to the exclusion of all others, are some of the things which make up the equipment of the Vivarium.

Associate Professor H. P. Barss has been promoted to be professor of botany and plant pathology at the Oregon Agricultural College, in place of Professor H. S. Jackson, who recently resigned to accept the position of plant pathologist at Purdue University.

Dr. Albion Walter Hewlett, professor of medicine at the University of Michigan, has accepted a similar appointment, beginning on August 1, 1916, in the Medical School of Stanford University. This fills the vacancy left by the appointment of Dr. Ray Lyman Wilbur as president of the university.

Assistant Professor A. L. Lovett has been made acting head of the department of entomology at the Oregon Agricultural College, in place of Professor H. F. Wilson, who resigned to accept a position as professor of entomology at the University of Wisconsin.

Count Hutten-Czapski, of Posen, has been appointed curator of the Warsaw University and Technical School, as reestablished under German auspices.

DISCUSSION AND CORRESPONDENCE

THE TEACHING OF ELEMENTARY DYNAMICS

To the Editor of Science: Since I took a hand, in Science of March 29, 1915, in the controversy between Professors Huntington and Hopkins concerning the fundamental equation of dynamics, there have appeared numerous communications on the subject showing evidence of widespread interest in it. As a result of these communications, the questions at issue are now in a more chaotic state than they ever were. The time now seems opportune for a review of the positions held by the several contributors, in the hope that they may yet be brought into agreement. I offer here some brief extracts from letters that have appeared in Science in the last six months, with my comments upon them, together with a condensed restatement of the problem I gave, with my solution of it, in my previous article, again asking that if any one thinks he has a better solution he will present it for comparison.

Uniformly Accelerated Motion

Problem.—A constant force, F pounds, acts for T seconds on W pounds of matter, at rest at the beginning of the time but free to move. What are the results? Explain how the results are derived.

Answer.—Experiments with the Atwood machine and other apparatus show (a) that the velocity varies directly as the force and as the time, and inversely as the quantity of matter;

(*b*) that the distance or space traversed varies as the force, as the square of the time, and inversely as the quantity of matter. It equals half the product of the velocity and the time. Expressed in algebraic form:

Velocity, feet per second,

$$V = \frac{FTg}{W}. \qquad (1)$$

Distance, feet,

$$S = \frac{1}{2}\frac{FT^2g}{W}, \qquad (2)$$

$$S = \frac{VT}{2}. \qquad (3)$$

The value of g in these equations is always 32.1740 when W is the quantity of matter in pounds, as determined by weighing it on an even balance scale, F is in standard pounds of force (1 pound of force being the force with which a pound of matter is attracted to the earth at the standard locality, a place where the "acceleration due to gravity" is 32.1740 feet per second per second), and V is measured in feet per second. (In the metric system, if F and W are in grammes and V in centimeters per second, $g = 980.665$.)

Transposing (1),

$$FT = \frac{WV}{g};$$

or if

$$M = \frac{W}{g}, \quad FT = MV. \qquad (4)$$

From (3),

Impulse = Momentum.

$$T = 2S/V;$$

substituting this value of T in (4)

$$2\ FS/V = MV;$$

whence

$$FS = \tfrac{1}{2}\ MV^2. \qquad (5)$$

In (4) let

Work done = Kinetic energy.

$$V/T = A,$$

acceleration, then

$$A = M/F.$$

Whence

$$F = MA.$$

Force = M times acceleration.

Falling Bodies.—At or near 45 deg. latitude at the sea level $F = W$, then from (1) we have $V = gT$. If $T = 1$ second $V = 32.1740$ feet per second. At other locations, $F = W \times (g_1/g)$, or $Wg/32.1740$, where g_1 is the acceleration due to gravity at the given location. In equation (1) $V = FTg/W$, taking $F = W$, substituting for T its value $2S/V$, and for S the letter H, for height of fall, we obtain

$$V^2 = 2\ gH; \quad V = \sqrt{2\ gH}. \qquad (7)$$

The expression Wg_1/g may be called the "local weight." It equals the gravitational attraction, measured in standard pounds of force, upon W pounds of matter. It is the weight that is indicated on a spring balance calibrated for the standard locality, so that it will measure standard pounds of matter at 45° at the sea level and standard pounds of force at any locality whatever.

Professor Hoskins, April 23:

> . . . introduce at the outset the body-constant which was called by Newton *mass* or *quantity* of *matter* . . . the acceleration of a body depends quantitatively upon both the applied force and the mass of the body . . . and the still more concise form $A = F/m$ results if units are so chosen that *unit force acting upon unit mass causes unit acceleration.*

There is no objection to these statements if it is clearly understood what is meant by the terms unit force and unit mass, but Professor Hoskins might have gone further and shown that this form of equation results if F is in dynes and m in grams or if F is in poundals and m in pounds, or if F is in pounds and m in slugs, but that is *not true* if F and m are both in pounds. It is true, however, if it is understood that F is standard pounds of force and that m is merely a symbol for the ratio W pounds of matter divided by 32.1740.

> Standard weight defined as the force required to give the body the acceleration 32.1740 ft. per sec. It is important to make clear the fact that the quantity called standard weight is in reality the measure of a body constant and is quite independent of gravity in spite of the fact that it is given a name which is almost always associated with gravity.

Professor Hoskins and I are here in exact agreement, but I am not sure that he is aware

of it. I hold that the standard weight of a body is the number of pounds of force required to give the body the acceleration 32.1740 ft. per second, whether that is the earth's gravitational attraction on the body at the standard locality or whether it is the force required to slide it along a frictionless plane with the same acceleration. It is also the measure of a "body-constant," viz., the constant quantity of matter in the body, as determined by weighing it on an even balance scale, which is quite independent of the value of the force of gravitation at the place where the weighing is done. The quantity of matter might also be determined by multiplying its volume by its specific gravity, or, if its specific heat were known, by finding how many degrees it would heat a given volume of water. For example, a piece of iron in cooling 100 deg. F. heats a cubic foot of water 1 deg., what is its weight, the specific heat of the iron being 0.111, and 62.36 British thermal units being required to heat a cubic foot of water one degree? Answer, $62.36 \div (100 \times 0.111) = 5.62$ lbs.

In other words, weight, or standard weight, is both a quantity of matter and a force. While matter and force are two entirely different things, force being a push or a pull and matter something that may be pushed or pulled, the quantity of matter in a body may be determined by finding how much force is required to lift it. Both the quantity of the matter and the amount of force are called the weight of the body. They are different things, but numerically they are the same. The weight of a 1 lb. weight (piece of metal) is one pound, that is there is a pound of matter in it, and the force required to lift it is also called its weight and is a pound, of force (not a pound-weight, with or without the hyphen, for that is a term that is properly applied to a piece of metal used for weighing other bodies).

This double definition of the word weight is sanctioned by a thousand years of usage. It is universal in literature and in commerce. In the vain attempt to get rid of it the text-book writers have substituted the word "mass" for weight, meaning quantity of matter, and tried to confine the word weight to mean the amount of gravitational force acting on a body; but the great public will not have it so; they will continue to call both the force and the quantity of matter by the good old word weight. Then the text-book writers thought it would be a good thing to hybridize the C.G.S. system with the English system of weights and measures, and say unit force is that force which gives unit mass unit acceleration, and they invented the poundal to achieve this result; then, that device leading to trouble and confusion, they invented the gee-pound or slug and so increased the trouble.

In fact it (a supported body) has an acceleration even though at rest relatively to the earth.

I do not understand Professor Hoskins here. If acceleration means change of velocity divided by time, and rest connotes no change of velocity and no velocity, how can a body at rest on the earth's surface have an acceleration relatively to the earth, that is radially toward the earth's center, or relatively to a fixed point in space, if there is no change in the speed of rotation of the earth?

Professor Hoskins, May 7:

Mr. Kent's equation $V = KFT/W$ is entirely satisfactory and sufficient so long as our study is confined to the cause in which a force whose direction and magnitude remain constant acts upon a body otherwise free and initially at rest. This is, however, a very exceptional case. The fundamental principle in its generality can be expressed only by introducing the notion of instantaneous rate change of velocity, *i. e.*, acceleration.

I am glad that Professor Hoskins admits the sufficiency of the equation for the particular case to which I applied it, that of the body initially at rest acted on by a force constant in magnitude and direction. I call this equation fundamental because it is derived from experiment with the Atwood machine or other apparatus, and because it is a foundation upon which other equations may be built. Now let us build on it to arrive at the general case, by removing the restrictions of the original problem. Take unit force as the force which acting for one second gives a pound of matter a velocity of 32.1740 feet per second, then the

equation becomes $V = 32.1740\ FT/W$. Remove the restriction that the body starts from rest, and let it have at a given instant a velocity V_1 and at the end of the time T a velocity V_2. Let $V = V_2 - V_1$, then the equation applies equally well to this case, if we define V as the *increase* of velocity during T seconds.

Now remove the restrictions that the body is not retarded by friction and that the force is constant. The velocity then will not vary directly as the time, but in some other way, which can be expressed graphically by plotting velocities or distances against time. The problem is now not one of uniformly accelerated motion and it belongs to another chapter of the discussion, but we can still use the same formula if we differentiate it, assuming that for a differential of the time the force and the quantity of matter are constant. We then have $dv = 32.1740\ F/W\ dt$ or $dv/dt = 32.1740\ F/W$. This is a formula for the general case, but it is not fundamental; it is derived from the fundamental equation $V = FTg/W$ after dividing both sides of the equation by T. The notion of instantaneous rate of change of velocity, *i. e.*, acceleration, is not introduced until we give the name acceleration to the quantity dv/dt (or V/T if the acceleration is constant), and the term mass does not appear until we give the name mass to the quotient W/g and thus derive $A = F/M$, or $F = MA$, a most useful equation when we define M as W/g, but it is derived and not fundamental.

Professor Fulcher, April 30:

> Gravitational force overcome—weight raised.
> Elastic force overcome—spring stretched.
> Frictional force overcome—sled dragged.
> A pound weight (lb. wt.) is the force required to lift 3.55 cu. in. of iron.

I approve of Professor Fulcher's method of progressing from matters of every-day experience, and it is the method I use, as shown in my article in SCIENCE, December 24, 1909. I am glad to see that he uses the words "weight raised" instead of "mass raised," for the words are in harmony with the young student's understanding of the word weight. I should prefer, however, to say elastic resistance and frictional resistance, instead of elastic force and frictional force. The use of "pound weight (lb. wt.)" instead of the term "pound force" I consider objectionable. The word weight is now used correctly and generally in common language with two meanings, (1) quantity of matter (determined by weighing it on an even balance or by multiplying its volume by its specific gravity), and (2) the force with which the earth's gravity attracts that matter; while the words "pound weight" have a specific meaning, viz., a piece of metal marked 1 lb., used in weighing. Neither "weight" nor "pound weight" are properly applied to the horizontal force required to drag a sled or to a vertical force of 1 lb., as measured on a spring balance, exerted (vainly) to lift a 2 lb. weight.

> Before we can determine the effect of a constant unbalanced force in changing the motion of a body, we must study some simple types of motion: (1) uniform; (2) constantly changing speed; (3) parabolic motion; (4) uniform circular motion; (5) motion due to a constant gravitational force.

I would teach (1) very briefly and postpone (2), (3) and (4) until after (5) had been studied experimentally with Atwood's machine, and until after the problem of a heavy boat in still water, pulled with a very small force, say 1 lb. on a 1,000-lb. boat for 4 seconds (frictional resistance neglected) had been studied, deriving the general equation of constant acceleration (2) from the experimental data.

Gravitational Units.—I would drop this term and substitute two others, (1) English units: pound, foot, second, (2) metric units, kilogram (or gram) meter (or centimeter), second. These units are absolute if W is defined as quantity of matter obtained by weighing on an even balance scale and g is 32.1740 ft. per sec. = 980.665 cm. per sec.

Absolute Units.—I would drop this term, also the poundal, and substitute C.G.S. (centimeter-gram-second).

Alexander McAdie, April 30:

> Now what is the difficulty with the C.G.S. system?

The difficulty pedagogically is the definition of the dyne, the force that gives a gram of matter an acceleration of 1 centimeter per second per second, and the fact that it has to be translated into its equivalent in ordinary language, a force of 1/980.665 gram, before a clear concept of it can be obtained. If it had been defined as the force which gravity exerts on a gram of matter at 45 deg. latitude at the sea-level, it would have been better. Practically the difficulty is that C.G.S. units derived from the dyne are generally so small that they usually have to be multiplied by a million or more to make them usable, or to express them in such terms as "the joule is 10^7 ergs," and "the ohm is equal to 1,000,000,000 or 10^9 units of resistance of the C.G.S. system."

It is not so difficult for one to break away from the old units as may be imagined. A year's constant use of the C.G.S. units makes one feel like saying when reading of inch measurements "Inch, inch? Where have we met that term before?"

Of course it is not difficult for *one* who is engaged constantly in the use of the C.G.S. system, and who during that year has had no occasion to use the old units, to break away from them, but it is not only difficult but impossible, for a hundred million people who are constantly using the old units to break away from them.

T. L. Porter and R. C. Gowdy, June 4:

We think Professor Kent has done well to retain force and quantity of matter as equally fundamental.

Thanks! I am glad of their company so far, but I can not follow them in adopting the "gravital" as a unit of acceleration. I invented that term myself years ago, as a distance of 32.2 feet, only for the purpose of using it as a "horrible example." I fear now that some one else will adopt my "timal," 1/32.2 of a second. Still less can I accept their microspeedal or their six Greek letter constants. Perhaps my sense of humor is lacking, in failing to recognize that their article is a joke and a satire, but it reads as if they seriously mean all they say. Here are some brief quotations from their article.

Let W = matter in pounds.
F = force in pounds.

Mass shall be an exact equivalent for quantity of matter.

Weight means the gravitational *force* upon a mass.

The measure of a force may be defined by the equation $F = ma$.

There are 32.2 of the units of force defined by $F = ma$ in a pound weight.

What is the *unit* of m if not the slug?

We frankly talk about a unit of force called the poundal.

If I understand this rightly Messrs. Porter and Gowdy measure matter in both pounds and in slugs, and force in both pounds and in poundals, and to my mind this only increases the existing confusion.

I have just looked over the solution of my problem and I find that it contains twelve technical terms, including one constant, viz., force, pounds, matter, seconds, velocity, distance, acceleration, impulse, momentum, energy, work; $g = 32.1740$.

Messrs. Porter and Gowdy's article contains the same twelve, and also fourteen additional ones, viz., micro-speedals, gravitals, mass, weight, poundals, slugs, pounds-weight, unit and six Greek letter constants. The object of my work has been to eliminate as many useless terms as possible, with the view of making the subject of dynamics easier. Their object seems to be to use as many terms as possible. I wish they would give my problem to a class of their students, and ask them to take it home and bring in written solutions in the method in which they have been taught. The problem for this purpose might have added to it one to be solved arithmetically, such as a 1,000-lb. boat is pulled with a force of 1 lb. for 4 seconds. Assuming that frictional resistance may be neglected, find the distance, velocity, acceleration, etc.

Paul F. Gaehr, June 25:

I say that we may take as our unit of force that force which gives to unit mass a unit acceleration. Let us fetch that backward baby, the poundal, into the room for an inspection at least long enough to learn that the weight of a pound is 32 poundals.

Yes, we may inspect that backward baby a

while, but the students will forget it, just as the students do who are told that we may take as our unit of mass that mass to which unit force (1 pound) gives unit acceleration, and are asked to inspect that more modern baby the slug, alias gee-pound, which will also be forgotten.

Why not teach that the unit of force is that force (1 pound) which gives to unit quantity (1 pound) of matter (call it weight or mass as you will) an acceleration of 32.1740 feet per second, or the force with which a pound of matter is attracted to the earth at a standard locality? That baby was pretty old before the poundal and the slug were born, and now as a strong man is about to attend their funeral.

Professor Huntington, July 30:

> (P. 158) Professor Hoskins's method presupposes as a matter of common knowledge the difficult concept of mass or inertia, while my method postpones the introduction of this concept until the student is in a position to define it in terms of the simple concepts of force and acceleration.
>
> (P. 159) Mass as a factor in the determination of motion means the constant ratio of force to acceleration, and whatever the words quantity of matter convey to a beginner's mind they certainly can not convey this desired idea of mass and inertia until *after* the ideas of force and acceleration and the idea of constancy of their ratio for a given body has been accepted.

If $FT=MV$, then $FT/V=F/A$; $F=MV/T=MA$; $T=MV/F=$Momentum/Force; $V=FT/M=$Impulse/Mass. Mass no more means the ratio of force to acceleration than force means the time-rate of the increase of momentum, or that time means the ratio of momentum to force, or that velocity means the ratio of impulse to mass. These equations are merely algebraic statements of numerical equality. Not one of them is a definition. Moreover, they are not true, if mass and force are both measured in pounds or in kilograms. They are true in the C.G.S. system, in which force is measured in dynes and mass in grams, and also in the hybrid systems in which force is in poundals and mass in pounds, or force in pounds and mass in slugs. They are also true if it is understood that M is just a symbol for $W \div 32.1740$, W being weight, the word weight being defined as both the force which gravity exerts on a body where $g=32.1740$ and the quantity of matter in pounds as determined by weighing it on an even balance scale.

There is no difficulty whatever in the beginner's mind in the "concept" of weight with this double definition; his difficulty begins when he is told by the text-books and the teachers that weight is a variable quantity changing with locality, and that mass according to some writers means quantity of matter in slugs, by others it means ratio of force to acceleration, by others that it means the constant ratio of a variable weight (force of gravity) on a body to a variable value of g, and by still others that it is the same thing as inertia.

> (P. 164) The awkward attempt to make mass the fundamental unit and force the derived unit has been practically abandoned in the accepted terminology of pure science. Why should it not be abandoned in elementary teaching?

Certainly it should be abandoned, and so also should be abandoned the equally awkward attempt to make mass a derived unit, the ratio of force to acceleration. As Professor Hoskins says in his footnote (page 610, April 23):

> Professor Huntington's statement that the mass concept is a "derived concept both historically and practically" is hardly true in any sense in which it is not also true of force. At all events, mass in the sense of quantity of matter has been treated as fundamental by many high authorities from Newton down.

Everybody (writers of text-books on mechanics and some teachers not excepted until they get into "pure science" and become metaphysical) knows that neither force nor quantity of matter are derived concepts; both are elementary and fundamental concepts. As I said six years ago in my article on "The Teaching of Elementary Dynamics in the High School":[1]

> *Matter.*—A stone is suspended by an elastic cord from a nail driven into a projecting shelf. The stone is a piece of matter. . . . Quantity of matter determined by weighing on an even balance scale. The weight of the stone is W pounds.

[1] SCIENCE, Dec. 24, 1909.

Force.—The cord is stretched when the stone is hung on it. Measure the stretch per foot of length. . . . But the cord may be stretched by pulling it between the two hands horizontally. . . . The pull of the earth upon the stone . . . the pull of the hands, . . . each is called by the name force, *F*.

Space. Time.—Let the cord be suddenly detached from the stone. The stone falls to the ground. It traverses a certain distance, *S* feet, in a certain time, *T* seconds.

Here are four elementary, fundamental and independent concepts. Neither one of them is derived from any function or ratio of the other three.

(P. 161) In regard to the equation $V = FTg/W$, which has been proposed by Mr. Kent, my feeling agrees with that expressed by Professor Hoskins, namely that no equation which covers only the special case of a body starting from rest . . . (can be considered as) a fundamental equation in mechanics. Mr. Kent's paper, however, is not without interest on the pedagogical side.

Not without interest! I have been told by those who have used my method that it is pedagogically admirable. The editor of Science has sent me a letter from an engineer in California enclosing 15 cents for a copy of Science containing my article, to be sent to his son in college, saying that in 25 years' experience it was the best presentation of the subject he had seen. I presented it on the blackboard at the Princeton meeting of the Society for the Promotion of Engineering Education, June, 1914, where I challenged the professors present that if they did not like my method they write out a better one. Thus far no one has accepted my challenge. The problem is not one of mechanics; it is one of a method of teaching; it is one of pedagogy and the English language, how to find a form of words to be put into a text-book to explain the fundamental principles of dynamics in a way that will appeal to the young student and get these principles into his head in the easiest way possible. After over a year of "watchful waiting" I have put a condensed summary of the method as given in my article in Science of March 19, 1915, into the chapter on Mechanics in the ninth edition of my "Mechanical Engineers' Pocket-book," which will be off the press about December 10. The young engineers who use the book will there find an antidote to what they have been taught in the past about poundals, slugs, gee-pounds, engineer's unit of mass, derived "concepts," "force is the time-rate of the increase of momentum," "mass is the ratio of force to acceleration," "the unit of mass is 32.2 pounds, the unit of force is 1/32.2 of a pound," and the like. I even have hopes that the Committee on Teaching of Mechanics, of the Society for the Promotion of Engineering Education, of which committee I am a disturbing member, disturbing the slumbers of the committee about once a year, will in two or three years more get over its negative acceleration or minus inertia and adopt my method in its final report.

Professor Hoskins, August 27:

That "the result of weighing a body on a balance scale" is a proper measure of "amount of material" certainly requires explanation to the beginner.

Not to a boy who understands the English language and has ever seen a grocer's scale used to weigh sugar.

I see no reason why the unit which has been called the slug should be regarded with ridicule or even semi-ridicule. The convenience of the slug is due to two facts (1) that the pound force is customarily employed in a great deal of practical work, and (2) that the dynamical formulas almost universally employed are based on a relation of units such that unit force acting on unit mass causes unit acceleration.

The dynamical formulas universally used by engineers are based on no such relation. They are (1) $FT = MV$, (2) $FS = \frac{1}{2}MV^2$, (3) $V = (FT/W) \times g$, and in each case where M is used it means simply W/g.

In order to make the equation $FT = MV$, in anything but the C.G.S. system, harmonize with the statement that "unit force acting on unit mass causes unit acceleration," we must do violence to the English language and custom and use an artificial expedient not sanctioned in literature outside of the text-books, or in commerce, or in engineering practise.

Thus we may say

$$F \times T = M \times V;$$

poundals × seconds = pounds × feet per second; 1 poundal = 1/32.2 pound force;
pounds × seconds = slugs × feet per second; 1 slug = 32.2 pounds;
pounds × timals = pounds × feet per second; 1 timal = 1/32.2 second;
pounds × seconds = pounds × gravitals per second; 1 gravital = 32.2 feet.

The timal and gravital are just as ridiculous or semi-ridiculous as the poundal or slug, and no more so. Neither one of them has any reason for existence except the pleasing alliteration, copied from the C.G.S. system, "unit force acting on unit mass causes unit acceleration." I see no reason why we should use this principle when it leads to no useful result, but does lead to the worse than useless ones of wasting the time of the student and confusing his mind. If it is such a good thing, why has it not yet been grafted on the metric system? Why do we not have kilogrammal as a unit of force and kiloslug as a unit of quantity of matter?

Is there any reason why in the English system we should not adhere to the good old principle, Unit force (pound) acting on unit mass (1 pound) gives it an acceleration of 32.1740 feet per second?

Professors Franklin and MacNutt, September 24:

> Let us retain as the fundamental meaning of the word mass the result of weighing on a balance scale. . . . Use a balance on a batch of sugar and you get always and everywhere the same numerical result. . . . We respect the experience of two thousand years in that we base our definition of mass on the use of the balance.

I have no objection to the physicists' using the word mass in this sense, but they should not try to prevent their students from using the word weight in the same sense; and I do object to their telling their students that the unit of force is a poundal, when all the rest of the world says it is a pound.

Professor Wilson, October 15:

> To obtain valuable training in kinetics a knowledge of the differential and integral calculus, including the simpler differential equations, is necessary . . . . We therefore have the fundamental equation of kinetics in the form $d/dt\ (mv) = gf$.

The calculus is not at all necessary when we are dealing with uniformly accelerated motion, and valuable training in kinetics was obtained in the study of the early editions of Weisbach, in which calculus was not used. In fact when the problem involves acceleration not constant, but varying according to some assumed law a graphical or arithmetical solution of it will be more useful training than its solution by the calculus. Let Professor Wilson give to his students the boat problem with frictional resistance added and find what results they get by applying his differential formula to it. The problem is: A boat with its load, the total weighing 1,000 pounds, is towed in still water with a constant force of 1 pound. The frictional resistance is $0.2v^2$ pounds, v being speed in ft. per sec., and the force available for acceleration is $(1 - v^2)$ pounds. What speed will the boat have at the end of 1, 2, 3 and 4 minutes; how far will it travel each minute and how long time will it take to bring it to a speed of 0.999 of the theoretical maximum at which the acceleration is zero?

> It is of course true that weight is not a definite constant thing from place to place.

It is a constant thing if weight is defined, as is customary in commerce, as the quantity of matter in pounds determined by weighing it on an even balance.

> . . . proceed to Newton's law that the rate of change of momentum is equal to the force. Here however we have an equation that is no longer homogeneous either in the mass or in the force.

This is a new kind of language to me. I confess my ignorance of the meaning of the phrase "homogeneous either in the mass or in the force." Whatever it may mean it surely has no place on "elementary" mechanics.

> The equation $ma = f$, or any equation involving accelerations leads to the ridiculously needless concepts of transverse and longitudinal (and an infinity of oblique) masses.

Here again Professor Wilson is too deep for me. I have used the equation $ma = f$ for forty years (understanding that m means the quotient w/g) and never have been led to any such concepts. I thank Professor Wilson for the expression "ridiculously needless con-

cepts." It fits exactly the poundals, slugs, geepounds, engineers' unit of mass, gravitals, micro-speedals, kinetic unit, scientific unit, absolute and gravitational systems, "concepts of mass," "force is the space rate at which work in foot pounds is done, it is also the time rate at which momentum is produced or destroyed" (Perry's "Calculus") and all such pedagogical rubbish.

Our first object is to get the student into a position where he can solve such simple problems as he sees in actual work about him, and a certain amount of ignorance which would be very lamentable on the part of myself and your other contributors, is highly praiseworthy in the student.

Good! Now will Professor Wilson examine the simple problem I have given and my method of solving it and get one of his instructors to experiment on the method with some freshmen students and report the result? "Try it on the dog." Test it not only by the canons of logic and of common sense, but also by experience.

Any student knows what a weight of four pounds is.

Of course he does, until he begins the study of physics; then he may be in some doubt about it. He knows that it is a piece of metal with "4 lb." stamped on it, but when he is told that that is not a weight, but mass, and that a weight of four pounds means a force of four pounds, also that a mass is "the constant ratio of force to acceleration," and that "he can not acquire the desired ideas of mass and inertia until after the ideas of force and acceleration have been accepted," it is no wonder that he becomes confused, and replies to the simple question, "What is force?" "The time-rate of the change of momentum," quoting from the text-book, without knowing what the words mean.

Wm. Kent

A MNEMONIC COUPLET FOR GEOLOGIC PERIODS

Several years of experience in teaching geology led me, some time since, to the invention or discovery of the following scheme for helping students to remember the order of geologic periods.

The form offered here is adapted to the plan presented in Chamberlin and Salisbury's "College Geology," which is widely used. It may be modified without serious difficulty to suit other time divisions.

Neglecting the Pre-Cambrian, somewhat as common histories do pre-historic time, and also the recent epoch, we take the periods of the Paleozoic era, Cambrian, Ordovician, Silurian, Devonian, Mississippian, Pennsylvanian and Permian; of the Mesozoic, Triassic, Jurassic, Comanche and Cretaceous; and of the Cenozoic, Eocene (Oligocene), Miocene, Pliocene and Pleistocene.

Taking the first syllable of each period, and adding the termination *ice* to the Permian to commemorate the glacial epoch of that time, and also to rhyme with "Pleis," which also reminds one of the better known epoch of the same sort, we have the following jingle:

Cam.Or.Sil.De.
Miss.Penn.Perm-*ice*,
Tri.Ju.Co.Cre.
E.(Ol.).Mi.Pli.Pleis.

Some of the divisions here counted periods may be more fittingly called epochs, but that makes no difference with the order.

J. E. Todd

University of Kansas

VARIATION IN ŒNOTHERA HEWETTI

Dr. G. H. Shull[1] recently published a paper on "A Peculiar Negative Correlation in *Œnothera* Hybrids," in which he showed that in certain cultures dull dark red stems were associated with entirely green buds, and gave other evidence indicating that the appearance of anthocyan in one part of the plant by no means involved its appearance in other parts.

I have this year a series of plants of *Œnothera hewetti*, descended from the original plant brought from the Rito de los Frijoles, New Mexico, in 1912. This is a relative of *Œ. hookeri*, and quite distinct from the species used by Dr. Shull. Nevertheless, it varies in pigmentation along practically the same lines.

[1] *Journal of Genetics*, IV., 1914, p. 83.

Thirteen plants examined fall into three groups, as follows:

(*a*) Stems and midribs of leaves dark crimson; buds entirely green. Three.

(*b*) Light green stems, slightly speckled or washed with reddish; midribs light green; calyces broadly striped with red, as de Vries[2] figures for *Œ. hookeri*. Six.

(*c*) Red stems and mid-ribs, and red-striped buds. Four.

Thus there is rather absence of correlation than negative correlation, except that no green-stemmed plants with green buds were found.

Mr. H. H. Bartlett, who grew *Œ. hewetti* from my seed in 1914, found the plants diverse, and mostly self-sterile, which led him to suggest (in litt.) that the form might be of hybrid origin. My plants seem quite uniform except in color, as described above, and in the size of the flowers, which seems to vary largely according to the condition of the plant, or on the same plant according to position.[3] No other *Œnothera* was observed in the original locality of *hewetti*, and the only species growing in the vicinity at Boulder (until last summer, when I had a single small plant of *Œ. rubricalyx*) is *Œ. cockerelli* Bartl., one of the small-flowered group. It seems probable that *Œ. hewetti* is a pure species, which varies or mutates in the same manner as other members of the genus.

I have this year a very fine plant of *Œ. rubricalyx*, which is even redder than Gates's original figure,[4] having the buds, including the hypanthium, entirely dark red, excepting the green sepal tips. The stems are dark red, more or less streaked with green, but the midribs are green, only faintly speckled with red. Thus this intensely pigmented plant has the midribs much less pigmented than in the red-stemmed form of *hewetti*, although the buds are very much more intensely pigmented than in the latter.

T. D. A. COCKERELL
UNIVERSITY OF COLORADO,
July 18, 1915

[2] "Gruppenweise Artbildung," pl. VIII.

[3] This refers to the grown plants. Some diversity in the rosette leaves was noted.

[4] *Zeits. f. indukt. Abstammungs-u. Vererbungslehre*, Bd. 4, pl. 6, f. 8.

QUOTATIONS

THE CONVOCATION-WEEK MEETINGS OF SCIENTIFIC SOCIETIES

THE scientific men of the country will hold their annual meetings this year at widely separated places and with some conflict. The American Association for the Advancement of Science is responsible for the arrangement of the convocation-week meetings, having fourteen years ago transferred its own meeting from mid-summer to the Christmas holidays. At the same time it obtained from many universities and colleges an extension of the Christmas holidays or grants for leave of absence, so that the week in which New Year's day falls should be free for these meetings. The American Association arranges also for the meetings of affiliated scientific societies which may wish to meet in conjunction with it. It is not expected that all these societies will meet every year with the association, for there are obvious advantages in the isolation of a single society or a small group concerned with related subjects, as well as in a large congress covering all the sciences and numbering its attendance by the thousands.

In order to meet the complicated conditions as well as may be, the American Association has planned a program, according to which once in four years there shall be a great convocation-week meeting representing all the natural and exact sciences, and perhaps, ultimately, also engineering, education, economics, history, philology, literature and art. Such a demonstration of the intellectual forces of the country should be a stimulus to those who join in it and an exhibition that would impress the whole country. It is proposed to hold these meetings once in four years and in succession in New York, Chicago and Washington. The first will take place in New York at the end of the year 1916, and thereafter they will he held in the four-year periods at which the national presidential elections occur. In the intervening two-year periods the meetings will also be in large scientific centers, and it is expected that most of the national scientific societies will take part. The first of these meetings was held in Philadelphia, and the next will probably be held in Boston at the

end of the year 1918. In the intervening years the American Association will meet at places more remote from the large centers of scientific population, or in cities or at universities where the accommodations are more limited. The first of these meetings was in Atlanta at the end of the year 1913, and the meeting this year is at the Ohio State University, Columbus. In 1917, it will probably be in Toronto, Nashville or Pittsburgh.

At these meetings the attendance of scientific men is in the neighborhood of a thousand; at the larger meetings it may be two or three thousand, and at the four-year periods, from five to ten thousand. The vast extent of the country makes it difficult for the scientific men of the west to visit the east, and conversely, during the Christmas holidays, and summer meetings may be held in the west once in four years, the first having been held this summer in connection with the Panama-Pacific Exhibition, and on the occasion of the organization of a Pacific Division of the Association.

Although the meeting of the American Association opening at Columbus, on December 27, is not one of the larger convocation-week meetings, it promises to be of more than usual interest to those who are able to be present, as was the case with the meeting held at the Ohio State University some fifteen years ago. The address of the retiring president, Dr. Charles W. Eliot, who, called from a chair of chemistry to the presidency of Harvard University, has become by common consent our leader in education, is on "The Fruits, Prospects and Lessons of Recent Biological Science." An introductory address will be made by the incoming president, Dr. W. W. Campbell, the distinguished director of the Lick Observatory. Among the vice-presidential addresses before the eleven sections of the association may be noted important subjects, treated by Professor White, of Vassar College, in mathematics; Professor Zeleny, of Yale University, in physics; Professor Lillie, of the University of Chicago, in zoology; Professor Pearce, of the University of Pennsylvania, in pathology; Professor Hanus, of Harvard University, in education, and Dr. Bailey, formerly director of the Cornell Agricultural College, in agriculture.

Eighteen national societies, including the American Society of Naturalists, and the societies devoted to mathematics, physics, zoology, entomology and botany meet at Columbus in affiliation with the American Association. The chemists do not hold a winter meeting this year. The psychologists and pharmacologists meet in Boston; the anatomists in New Haven; the psychologists in Chicago; the philosophers in Philadelphia; the geologists, paleontologists, geographers, anthropologists, sociologists and economists in Washington.

The serious conflict of the year is with the Second Pan-American Scientific Congress meeting in Washington from December 27 to January 8. It was originally planned that this congress should meet in the autumn, but the date was changed and the preliminary arrangements were made without consultation with American scientific men. The officers of the congress, selected presumably by the department of state, are Mr. Phillips, the third assistant secretary of state, chairman of the executive committee; Mr. Scott, secretary of the Carnegie Endowment for International Peace, vice-chairman; Mr. John Barrett, secretary-general; and Mr. Glen L. Swiggett, assistant secretary-general. The department of state is probably as ignorant of the scientific conditions of the country as the navy department, whose secretary when asked why he had ignored the National Academy, by law the scientific adviser of the government, and the American Association, the great democratic body of scientific men, in selecting the societies to elect members of the Naval Advisory Board, appeared never to have heard of either association. A program in nine sections has been arranged for a "scientific" congress, which ignores mathematics, physics, pure chemistry, geology, zoology, botany and psychology.

However, attempts have been made to rectify the earlier errors. Dr. Welch, president of the National Academy of Sciences, has been made honorary vice-chairman, and Surgeon-General

Gorgas, Dr. Holmes and Dr. Woodward have been added to the executive committee. The conflict in time does not extend to the second week of the Pan-American Congress, and it is probable that after the adjournment of the Columbus meeting a special meeting of the American Association will be held at Washington. Under existing conditions, it is extremely desirable that friendly relations and cooperation in science should be maintained among the American republics.—*The Scientific Monthly.*

SCIENTIFIC BOOKS

Elemente der exakten Erblichkeit mit Grundzügen der biologischen Variationsstatistik. By W. JOHANNSEN. Zweite deutsche, neue bearbeitet und sehr erweiterte Ausgabe. Jena, G. Fischer. 1913. 724 pp.; 35 figs. in text.

The second edition of Johannsen's epoch-making work which follows the first by only four years has added nearly 200 pages, or 40 per cent., to the first edition. The number of lectures has been increased from 25 to 30, by the division of one to which much material has been added, by wholly new lectures (Nos. 12, 13) and by five final lectures instead of three.

The significance of Johannsen's book can now, after the lapse of years, be better evaluated than before. It had long been a truism in biology that the hereditary substance—the stirp or germ—must be carefully distinguished from the person or soma, and Galton was one of the earliest to make this distinction. It was, therefore, a great step backward when Galton announced his law of ancestral heredity according to which an individual inherits from his two parents together 50 per cent. of his whole heritage; from his four grandparents 25 per cent., and so on. It only testifies to the depth of the darkness in which we were groping that any of us should have seized upon *that* as a solution of the mystery of heredity.

The rediscovery of Mendel's law wiped away that fog and brought us again to germ cells. Still we did not fully sense the bearings of that law. We still clung fondly to the idea that the soma was so important an index to the hidden germ plasm that we could make progress by somatic *selection.* And it required the first edition of Johannsen's "Elemente" to set us straight there. Ever since we have recognized that even if one can make progress by somatic selection it is more or less by accident and by rule-of-thumb. For what we are selecting is truly the germ plasm, even though we think we are selecting somas; and we are successful only in those cases in which there happens to be a considerable correlation between the two. Ever since Johannsen's book appeared somatic selection merely—as such—has been realized to be futile for evolution, although somatic selection as a means of eliminating or preserving certain kinds of germ plasm may be, and in some cases is, of great theoretical and practical importance.

In the new edition, new, original experimental material on pure lines in beans is afforded with results quite the same as before. More space is given to a critical examination of the later studies on selection such as the favorable ones of Jennings, East, Pearl, Tower and Gates and the unfavorable ones of Castle, Lutz and Harris among American investigators. The unfavorable investigators Johannsen finds to fall into two groups; those whose experiments have yielded results opposed to Johannsen's and those who, without contradicting his results, have opposed their general validity. The opposing experiments rest either on the fact that the original material was not homogeneous or result from a "secondary selection" such as the selection of the best nourished individuals whose young start life in each generation on a higher nutrition-plane even though no genotypic change has occurred. There seems to the reviewer a certain weakness in the author's explanation of the discordant results of some workers (*e. g.,* Lutz). It would seem more probable that some of the favorable results of selection are due to unexpectedly abundant mutation. The last 90 pages of the book contain the most new material. Here are recorded, with evidence of great research into the literature, the results of the newer experiments in hered-

ity; the various deviations from simple Mendelian proportions, hypostasis and latency, sterility and inbreeding. The author also treats of coupling and "repulsion" without being able to make use of the flood of light that Morgan and his pupils have thrown upon these ideas. Indeed, Johannsen at the time of writing the book was not inclined to ascribe to the chromosomes the importance in heredity that is commonly conceded to them in this country.

In his final chapter Johannsen considers certain relations of the results of heredity to man and to evolution. He thinks the fact that culture (euthenics) has no effect on the race makes it not less but the more significant; for the momentary position of the race is the summation of personal qualities. In a sense it is true that the worse the breeding the greater the need for cultivation if any sort of a crop is to be harvested. As for the bearing of the new facts of heredity on evolution Johannsen has little to say and he states that we miss today the genius of a Darwin to establish a theory of evolution in harmony with modern knowledge.

C. B. Davenport

Einführung in die Tierpsychologie. Erster Band, Die Sinne der Wirbellosen. Von Gustav Kafka. J. A. Barth, Leipzig. Pp. xii + 593. 8vo. 362 text illustrations.

Animal psychology, according to Kafka, takes its departure from the same body of facts that sensory physiology does, but differs from this subject in the problems it sets itself for solution. That most of these problems are still unsolved justified the author in his opinion that a good text-book on animal psychology should concern itself with the facts of animal reactions rather than with theoretic matter. The book holds consistently to this view. It contains, after a very brief introduction, an account of the rapidly accumulating material on the sense of touch, the static sense, the sense of hearing, the temperature sense, the chemical sense, the light sense, and the very questionable senses of space and of time, all in invertebrates. The volume is well illustrated and is concluded by a bibliography of over five hundred titles in a well-ordered arrangement. As an introduction to the newly discovered facts in animal reactions the volume is in every way serviceable, though from the rate at which the subject is growing the book is bound soon to fall behind the times. As a means of quickening in the student a sense of the general problems in this field of research, it is disappointing. This fault may be excused on the grounds that it is just this side of the subject that the author has intentionally avoided, but it is an open question whether this avoidance is really a virtue. While the volume from its clearness and directness of statement will be found of much use to the student of animal psychology and allied subjects, its failure to deal with the more obvious general problems of this field of science must be regarded as a real defect. Possibly this may be remedied in the companion volume on the vertebrate senses which is said to be in preparation by the same author.

G. H. Parker

SPECIAL ARTICLES

HEREDITY AND INTERNAL SECRETION IN THE SPONTANEOUS DEVELOPMENT OF CANCER IN MICE

After preliminary studies in 1901 and 1902, and subsequent observations in 1907 suggesting the significance of heredity in the spontaneous development of cancer in rats and mice, we undertook an analysis of the hereditary factors on a larger scale in 1910 in conjunction with Miss A. E. C. Lathrop in Granby, Mass.[1]

[1] Loeb, L., *Medicine,* 1900, VI., 286; *Centralbl. f. Bakteriol.,* I., Abt., Orig., 1904, XXXVII., 235; *Univ. Penn. Med. Bull.,* 1907–08, XX., 2; *Centralblatt. f. allg. Pathol.,* 1911, XXII., 993. Lathrop, A. E. C., and Loeb, L., *Proc. Soc. Exp. Biol. and Med.,* 1913, XI., 34. Loeb, L., *Lancet-Clinic,* 1913, CX., 664. Lathrop, A. E. C., and Loeb, L., *Journal Exp. Med.,* XXII., Nov., 1915, 646, and Dec., 1915, 713. The credit for the first investigations on a somewhat larger scale into the possible influence of heredity on the tumor incidence in mice belongs to E. E. Tyzzer (*Jour. Med. Research,* 1907–08, XVII., 155). The procedure

Without going into a detailed discussion of the various conclusions arrived at, it may suffice to state as one of the principal results that different strains of mice kept in the same environment, being given the same kind of food, differ very much in the frequency with which cancer occurs among them. (Carcinoma of the mammary gland in females is by far the most common kind of cancer in mice.) In some of them cancer may affect as many as 70 per cent. of the female mice, while in other strains only 2–3 per cent. are affected. In succeeding generations this percentage figure is fairly constant in different strains of mice. Equally characteristic for different strains seems to be the age at which cancer occurs; while in some strains it occurs at a relatively early age, in others it appears later in life. Such differences in the cancer age may exist even in strains in which the cancer incidence is similar.

These data are a prerequisite for further studies of factors responsible for the spontaneous development of cancer as well as for attempts to diminish or increase the cancer incidence at will. From a practical point of view such studies may ultimately lead to the discovery of means enabling us to lower the cancer rate or to prevent cancer. As a first contribution to this problem we undertook, on the basis of our previous results concerning the significance of heredity, an analysis of the influence of the ovary and especially of the corpus luteum in the spontaneous development of cancer of the mammary gland in mice. We had shown previously that a combination of a mechanical stimulus and the influence of a substance secreted by the corpus luteum at a definite period of its existence led to the production of rapidly growing tumor-like new formations with the structure of the decidua in all parts of the uterus. After a period of at first rapid and then declining growth they became later necrotic. We designated those tumor-like formations as "Deciduomata" or "Placentomata" and placed them among a category of new formations which we characterized as "transitory tumors."[2] Other investigators showed later that the corpus luteum was furthermore of significance for the periodic growth of the mammary gland, especially also during pregnancy.

These facts suggested a possible importance of the corpus luteum for the spontaneous development of cancer in mice. Accordingly, we undertook in conjunction with Miss A. E. C. Lathrop in Granby, experiments in this direction. Several lots of female mice of various ages belonging to strains rich in tumors were castrated, while other normal mice of the same strains were kept as controls. In other experiments a certain number of mice belonging to strains of known cancer incidence were prevented from breeding and thus the influence of the non-occurrence of pregnancies was tested. Under the latter condition the possible influence of a corpus luteum was not entirely abolished, but merely diminished. We wish to state briefly the results so far obtained: Castration of mice at or below the age of 6 months (corresponding to a period of life when the animals are already sexually mature) diminished the cancer incidence in a very pronounced way. The cancer rate fell from 60 per cent. to 70 per cent. in normal mice to 9 per cent. in castrated mice. Castration above the age of 6 months has so far been without any noticeable effect.

Non-breeding mice develop cancer in a somewhat smaller percentage of cases and at a somewhat higher age than normal breeding mice. The influence of prevention of breeding is therefore much less marked than the effect of castration, but considering the large number of mice we used it is not probable that the differences which we actually did observe were accidental. However, we are continuing our experiments in various directions and if accidental factors should complicate some of our results, this will become apparent during the further development of our work. We established thus two sets of factors in the etiology

used by Tyzzer (which was subsequently also used by T. A. Murray) could, however, not be depended upon to give decisive results.

[2] Loeb, L., *Centralbl. f. allg. Pathol.*, XVIII., 1907, 563, and a series of papers in the *Archiv f. Entwicklungsmechanik*.

of cancer (1) hereditary factors, and (2) chemical actions exerted by an internal secretion.

We could show that the hereditary factors are not identical with the internal secretion and do not act by changing the number of corpora lutea and their activity, but that their point of attack is somewhere else. It appears probable that with the cooperation of hereditary conditions all those internal secretions are factors in the origin of cancer which initiate or sustain continuous or periodic growth processes. In other cases mechanical stimulation of growth may take the place of chemical stimulation and again in others a combination of both may be present. Whether in addition to these factors definitely established there is still another factor (microorganisms?) present, and which relation this last-named hypothetical factor bears to the other two factors are at present unknown. But whether or not such an additional factor enters, we can be certain that the two first named sets of factors are sufficiently strong to determine to a great extent the frequency of cancer in mice.

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A NEW METHOD OF SELECTING TOMATOES FOR RESISTANCE TO THE WILT DISEASE

Perhaps the most serious disease of tomatoes in the southern states is that caused by *Fusarium lycopersici,* the one that is commonly known as the tomato wilt. The causative fungus lives in the soil and attacks the plants through the roots and later grows up through the fibrovascular bundles into the stems. In common with similar diseases of other plants, such as the wilts of cotton, watermelon, etc., the only practical method of control now known is in the use of varieties, or strains, that are resistant to the disease. By saving seed from healthy plants in a badly infected field for several seasons, strains can be obtained which show considerable resistance to the disease. This method of selecting the strains, however, has several serious drawbacks: (1) A large acreage of tomatoes is required as a large percentage of the plants which are set in the field die with the wilt. (2) Many of the plants in the field do not come in contact with the wilt fungus during the season and so do not have a chance to show whether they are resistant to the disease. (3) Resistant plants in the field are readily pollinated by the susceptible plants. (4) The time necessary to obtain a wilt-resistant strain is too long.

While studying the disease in Louisiana, an attempt has been made to improve on our common method of selecting resistant plants by selecting in the seed bed. This has been accomplished by taking advantage of the fact that soil diseases infect plants better if the soil is first sterilized and then inoculated with a pure culture of the disease organism. In ordinary unsterilized garden soil, even if it is heavily inoculated with the tomato wilt fungus, not many of the plants will show the wilt to any extent before it is time to place them in the field. The presence of bacteria and other fungi seems to have an inhibitory effect on the wilt fungus. If, however, the soil is first sterilized by heat and then heavily inoculated with the wilt fungus just before planting, the disease will develop so well that most of the susceptible plants will be killed before they are large enough to be placed in the field. By growing the plants in this manner, only plants showing resistance are placed in the field. This saves a great deal of field space and also allows a selection from an almost unlimited number of plants. This also assures the presence of the wilt fungus on the roots of every plant.

To show how this method of selection works in practise, results of some experiments may be briefly given. Having by the old method of selection obtained a strain that showed considerable resistance to the wilt disease, this was compared by the seed bed method with three standard varieties of tomatoes. The seed of each variety were planted side by side in reinoculated sterilized soil. Different cultures of the fungus from different localities were also used in order to see if they would affect the varieties differently. In the following

table are given the percentages of living plants and of wilt-free plants of each variety sixty-eight days after planting. Most of the living plants that were diseased could be told by an external examination, but for these results all living plants were cut and examined for the presence of the discolored fibrovascular bundles.

Variety.	Culture *A*.		Culture *B*.		Culture *C*.		Culture *D*.	
	Living, Per Cent.	Healthy, Per Cent.	Living, Per Cent.	Healthy, Per Cent.	Living, Per Cent.	Healthy, Per Cent.	Living, Per Cent.	Healthy, Per Cent.
Stone	35.3	11.8	75.0	55.0	44.7	25.5	71.4	57.1
Acme	14.3	0.0	42.9	28.6	31.3	21.9	65.8	31.6
Earliana.....	32.3	3.2	63.5	36.5	37.3	17.7	96.0	70.0
Wilt-resistant	62.5	31.3	.818	56.8	68.2	34.1	95.1	78.0

This table shows the comparatively greater resistance of the wilt-resistant variety as compared to the others, and it also shows the large percentage of susceptible plants that could be eliminated before setting in the field.

Although the investigations on this method are far from complete, it seems well at this time to put it into the hands of other workers with the hope that it may be found useful.

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DO MOVEMENTS OCCUR IN THE VISUAL CELLS AND RETINAL PIGMENT OF MAN?[1]

THE statement is commonly found in text-books of gross[2] and microscopical[3] anatomy, as well as in some texts of physiology,[4] that the retinal pigment of the human eye undergoes positional changes in light and in darkness. The pigment, which, in the dark, forms a compact layer next to the choroid, is said to migrate towards the external limiting membrane in the light, thereby forming processes which interdigitate with the rods and cones. If not explicitly stated, it is at least implied that this response is well marked and the actual migration extensive.

This view is so generally accepted as expressing a commonplace of retinal physiology that it is well worth while to examine the facts upon which its validity rests.

That photomechanical changes take place in the retinal pigment of anuran amphibians, a fact first established independently by Boll[5] and by Kühne[6] on the frog in 1877, may be substantiated by any one who will perform the necessary experiments. Similar results, in many cases even more striking, were obtained on fishes (Stort, '86).[7] Angelucci ('78)[8] likewise first reported this condition to hold for *Triton* as a type of urodele amphibian, and Stort ('87),[9] using the pigeon for material, again presented the earliest demonstration in the retina of birds.

When reptiles and mammals are considered, on the other hand, the literature at once becomes contradictory. Angelucci ('90),[10] however, reported a rather limited pigment migration in the retina of *Testudo marina,* and Chiarini ('06)[11] also states that a distinct but

[1] Contributions from the Zoological Laboratory of the Museum of Comparative Zoology at Harvard College, No. 263.

[2] *E. g.,* R. Howden, 1913, in Cunningham's "Anatomy," 4th ed., p. 817. E. A. Spitzka, 1910, in Gray's "Anatomy," 18th ed., p. 1106. Piersol, G. A., 1906, "Human Anatomy," p. 1463.

[3] *E. g.,* Bailey, F. R., 1913, "Text-book of Histology," 4th ed., p. 556. Piersol, G. A., 1913, "Normal Histology," 10th ed., p. 348.

[4] *E. g.,* Halliburton, W. D., 1910, "Handbook of Physiology," 9th ed., p. 843. Starling, E. H., 1912, "Principles of Human Physiology," p. 630 (by implication).

[5] Boll, F., 1877, *Monatsber. d. k. preuss. Akad. d. Wiss. zu Berlin,* pp. 72–74.

[6] Kühne, W., 1877, *Untersuch. a. d. physiol. Inst. d. Univ. Heidelberg,* Bd. 1, pp. 15–103, Taf. 1.

[7] Stort, A. G. H., Van Genderen, 1886, *Bericht über d. 18. Versamm. d. Ophthal. Gesell. zu Heidelberg,* pp. 43–49.

[8] Angelucci, A., 1878, *Arch. f. Anat. u. Physiol., Physiol Abt.,* pp. 353–386.

[9] Stort, A. G. H., Van Genderen, 1887, *Arch. neérland. d. Sci. exact et nat.,* Tom. 21, pp. 316–386.

[10] Angelucci, A., 1890, *Untersuch. z. Naturlehre d. Menschen u. d. Thiere,* Bd. 14, pp. 231–357.

[11] Chiarini, P., 1906, *Arch. ital. de Biol.,* Tom. 45, pp. 337–352.

limited pigment expansion was observed in the light-adapted eyes of the lizard.

With the exception of the early results of Angelucci ('78), who maintained that definite pigment movements occur in the rabbit, there exists only one positive record for mammals—that of Chiarini ('06), describing slight changes in the retina of dogs which had been exposed to direct sunlight and to darkness. The pigment of the light-adapted animals extended in short fringe-like processes between the rods, in contrast to the densely contracted pigment of the reciprocal set. Finally, Garten ('07)[12] carried out carefully executed experiments upon the ape, ox, rabbit and rat, yet failed to observe any striking differences between the effects of light and darkness; however, in the retina of the ape, which has a minute amount of pigment, composed of needle-like granules, the pigment was extended 3 to 4 granules deep in the light and only 2 to 3 granules deep in the dark.

When, in connection with experimentation upon the retinal pigment and visual cells of certain lower vertebrates, it became necessary to review the literature of this subject, I was at once impressed with the discrepancy between the statements found in many standard texts and the actual status of our knowledge, which, I believe, has been correctly summarized in the preceding paragraphs.

That slight positional changes due to photic stimulation have been detected in the retinal pigment of certain mammals, is probably true, but no evidence has yet been presented to show that a like condition holds for man. Moreover, if, in the future, such responses are demonstrated, the results upon other mammals (cf. Garten's experimentation upon apes) would lead us to expect them to be extremely limited. Since it follows, therefore, that the loose phraseology and the misstatements to be found in many standard text-books necessarily create fundamentally wrong impressions in the mind of the reader, it is evident that the future editions of all offending texts should avoid lending aid to the perpetuation of this popular misconception.

A phenomenon related to that of pigment migration is the contractility exhibited by a definite portion of the inner member of rods and cones. The so-called "myoid" of the cone-visual cell shortens to a marked degree when, in the case of many fishes and of some amphibians and birds, the retina is exposed to light. Among reptiles and mammals, changes in the length of the cone myoid are hard to observe, yet in both groups responses to light have apparently been detected in a few instances.

Among mammals, the results of Stort ('87) on the pig stand alone in ascribing striking positional changes to the cones; Stort's measurements of one dark-adapted human eye, moreover, do not prove that movements of the cones occur in man. Chiarini ('06) obtained negative results on the dog's eye, although Garten ('07), by careful experimentation upon apes, has been able to demonstrate slight changes in the region of the fovea. The assumption, on the part of writers, of the occurrence of movements in the cones of man has been relatively rare.

The rod myoids of certain fishes, amphibians and birds are likewise responsive when stimulated by light, yet nothing has been recorded concerning the existence of this phenomenon in mammals.

It is possible, as Garten ('07) suggests, that the changes in the retinal pigment and visual cells of mammals occur so quickly that the fixing fluids through slowness of penetration fail to preserve them in an extended condition.

Leslie B. Arey

[12] Garten, S., 1907, "Graefe-Saemisch, Handb. d. gesam. Augenheilkunde," Bd. 3, Kap. 12, Anhang.

THE CONVOCATION WEEK MEETINGS OF SCIENTIFIC SOCIETIES

The American Association for the Advancement of Science and the national scientific societies named below will meet at Columbus, Ohio, during convocation week, beginning on Monday, December 27, 1915:

American Association for the Advancement of Science.—President Dr. W. W. Campbell, Director Lick Observatory; retiring president, Dr.

Charles W. Eliot, Harvard University; permanent secretary, Dr. L. O. Howard, Smithsonian Institution, Washington, D. C.; general secretary, Mr. Henry Skinner, Academy of Natural Sciences, Logan Square, Philadelphia, Pa.; secretary of the council, Professor W. E. Henderson, Ohio State University.

Section A—Mathematics and Astronomy.—Vice-president, Professor A. O. Leuschner, University of California; secretary, Professor Forest R. Moulton, University of Chicago, Chicago, Ill.

Section B—Physics.—Vice-president, Professor Frederick Slate, University of California; secretary, Dr. W. J. Humphreys, U. S. Weather Bureau, Washington, D. C.

Section C—Chemistry.—Vice-president, Professor W. McPherson, Ohio State University; secretary, Dr. John Johnston, Geophysical Laboratory, Washington, D. C.

Section D—Mechanical Science and Engineering.—Vice-president, Bion J. Arnold, Chicago; secretary, Professor Arthur H. Blanchard, Columbia University, New York City.

Section E—Geology and Geography.—Vice-president, Professor C. S. Prosser, Ohio State University; secretary, Professor George F. Kay, University of Iowa.

Section F—Zoology.—Vice-president, Professor V. L. Kellogg, Stanford University; secretary, Professor Herbert V. Neal, Tufts College, Mass.

Section G—Botany.—Vice-president, Professor W. A. Setchell, University of California; secretary, Professor W. J. V. Osterhout, Harvard University, Cambridge, Mass.

Section H—Anthropology and Psychology.—Vice-president, Professor G. M. Stratton, University of California; secretary, Professor George Grant MacCurdy, Yale University; New Haven, Conn.

Section I—Social and Economic Science.—Vice-president, Geo. F. Kunz, New York; secretary, Seymour C. Loomis, 69 Church St., New Haven, Conn.

Section K—Physiology and Experimental Medicine.—Vice-president, Professor F. P. Gay, University of California; secretary, Professor C.-E. A. Winslow, Yale University.

Section L—Education.—Vice-president, Professor E. P. Cubberley, Stanford University; secretary, Dr. Stuart A. Courtis, Detroit, Mich.

Section M—Agriculture.—Vice-president, Professor Eugene Davenport, University of Illinois; secretary, Dr. E. W. Allen, U. S. Department of Agriculture, Washington, D. C.

COLUMBUS

The American Physical Society.—December 28–30. President, Professor Ernest Merritt, Cornell University; secretary, Professor A. D. Cole, Ohio State University, Columbus, Ohio.

The American Federation of Teachers of the Mathematical and the Natural Sciences.—Secretary, Dr. Wm. A. Hedrick, McKinley Manual Training School, Washington, D. C.

The American Society of Naturalists.—December 30. President, Professor Frank R. Lillie, University of Chicago; secretary, Dr. Bradley M. Davis, University of Pennsylvania, Philadelphia, Pa.

The American Society of Zoologists.—December 28–30. President, Professor William A. Locy, Northwestern University; secretary, Dr. Caswell Grave, The Johns Hopkins University, Baltimore, Md.

The Entomological Society of America.—December 29–31. President, Professor Vernon L. Kellogg, Stanford University; secretary, Professor Alexander D. MacGillivray, 603 West Michigan Ave., Urbana, Ill.

The American Association of Economic Entomologists.—December 27–30. President, Professor Glen W. Herrick, Cornell University; secretary, A. F. Burgess, Melrose Highlands, Mass.

The Botanical Society of America.—President, Professor John M. Coulter, University of Chicago; secretary, H. H. Bartlett, 335 Packard St., Ann Arbor, Mich.

The American Phytopathological Society.—December 28–31. President, Professor H. H. Whetzel, Cornell University; secretary, Dr. C. L. Shear, U. S. Department of Agriculture, Washington, D. C.

American Nature-Study Society.—December 30–31. President, Dr. L. H. Bailey, Ithaca, N. Y.; secretary, Professor E. R. Downing, University of Chicago, Chicago, Ill.

School Garden Association of America.—December 29–30. President, Van Evrie Kilpatrick, 124 West 30th St., New York, N. Y.

American Association of Official Horticultural Inspectors.—December 28–29. Chairman, W. E. Rumsey, Morgantown, W. Va.; secretary, Professor J. G. Saunders, State Capitol, Madison, Wis.

The American Microscopical Society.—December 29. President, Professor Chas. A. Kofoid, University of California; secretary, T. W. Galloway, James Millikin University, Decatur, Ill.

American Mathematical Society (Chicago Section).—December 30 to January 1. Chairman, Professor E. J. Wilczynski, University of Chicago; secretary, Professor H. E. Slaught, 5548 Kenwood Avenue, Chicago, Ill.

The Southern Society for Philosophy and Psychology.—December 28–30. President, Professor J. C. Barnes, Maryville College; secretary, Professor L. R. Geissler, University of Georgia, Athens, Ga.

Botanists of the Central States.—Will hold no separate meeting, but will present its papers in connection with Section G. President, Professor H. C. Cowles, University of Chicago; secretary, Dr. Edward A. Burt, Missouri Botanical Garden, St. Louis, Mo.

Society for Horticultural Science.—December 28–29. President, W. L. Howard; secretary, Professor C. P. Close, College Park, Maryland.

Association of Official Seed Analysts of North America.—December 28 and 29. President, W. L. Oswald; secretary, John P. Heylar, Agricultural Experiment Station, New Brunswick, N. J.

Society of Sigma XI.—December 28. President, Chas. S. Howe, Case School; secretary, Professor Henry B. Ward, University of Illinois, Urbana, Ill.

BOSTON

The American Physiological Society.—December 27–29. President, Professor W. B. Cannon, Harvard Medical School, Boston, Mass.; secretary, Professor Chas. W. Greene, University of Missouri, Columbia, Mo.

The American Society of Biological Chemists.—December 27–30. President, Professor Walter Jones, The Johns Hopkins University; secretary, Professor Philip A. Shaffer, Washington University Medical School, St. Louis, Mo.

The Society of Pharmacology and Experimental Therapeutics.—December 27–29. President, Dr. Torald Sollmann, Western Reserve University Medical School, Cleveland, Ohio; secretary, Dr. John Auer, Rockefeller Institute for Medical Research, New York City.

WASHINGTON, D. C.

The Geological Society of America.—December 28–30. President, Professor A. P. Coleman, University of Toronto; secretary, Dr. Edmund Otis Hovey, American Museum of Natural History, New York City.

The Association of American Geographers.—December 30–January 1. President, Professor R. E. Dodge, Teachers College, Columbia University; secretary, Dr. Isaiah Bowman, Broadway and 156th St., New York City.

The Paleontological Society.—December 29–30. President, Dr. E. O. Ulrich, U. S. Geological Survey; secretary, Dr. R. S. Bassler, U. S. National Museum, Washington, D. C.

The American Anthropological Association.—December 27–31. President, F. W. Hodge, Bureau of American Ethnology; secretary, Professor George Grant MacCurdy, Yale University, New Haven, Conn.

The American Folk-Lore Society.—Convocation Week. President, Dr. P. E. Goddard, American Museum of Natural History, New York City; secretary, Dr. Charles Peabody, 197 Brattle St., Cambridge, Mass.

The American Economic Association.—December 28–30. President, Professor W. F. Willcox, Cornell University; secretary, Professor Allyn A. Young, Cornell University, Ithaca, N. Y.

The American Sociological Society.—December 28–31. President, Professor E. A. Ross, University of Wisconsin; secretary, Professor Scott E. W. Bedford, University of Chicago, Chicago, Ill.

NEW HAVEN

The Association of American Anatomists.—December 28–30. President, Professor G. Carl Huber, University of Michigan; secretary, Dr. Charles R. Stockard, Cornell University Medical School, New York City.

URBANA

The Society of American Bacteriologists.—December 28–30. President, Dr. D. H. Bergey, University of Pennsylvania; secretary, Dr. A. Parker Hitchens, Glenolden, Pa.

NEW YORK CITY

The American Mathematical Society.—December 27–28. President, Professor E. W. Brown, Yale University; secretary, Professor F. N. Cole, 501 West 116th St., New York City.

CHICAGO

The American Psychological Association.—December 28–30. President, Professor John B. Watson, The Johns Hopkins University; secretary, Professor R. M. Ogden, University of Kansas, Lawrence, Kansas.

PHILADELPHIA

The American Philosophical Association.—December 28–30. President, Professor A. C. Armstrong, Wesleyan University; secretary, Professor E. G. Spaulding, Princeton, N. J.